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ABSTRACT

The development and use of financial planning models, with a focus on the Stanford University financial tradeoff (TRADES) methodology, are covered in conference papers, along with the application of the Stanford conceptual framework in five institutional settings. Additional papers consider an experimental modeling language that was developed to implement the Stanford methodology: the EDUCOM Financial Planning Model (EFPM). Titles and authors of the 12 conference papers include the following: "The Case for Planning Models" (William F. Massy, David S. P. Hopkins); "TRADES: A Model for Interactive Financial Planning" (Nathan Dickmeyer, D. Hopkins, W. Massy); "Models as Planning Tools: The Harvard Experiment" (Sally H. Zeckhauser); "Transition to Financial Equilibrium at Oberlin College" (James L. Powell); "Modeling the Budget at Lehigh University" (Eric V. (Ottervik); "Modeling and Planning at the University of Pennsylvania" (Jon C. Strauss, Randall Porter, Robert Zemsky); "Financial Planning at the State University of New York, Albany" (Robert C. Shirley, Wendell G. Lorang); and "EFPM--Generalizing the Stanford TRADES Model" (Daniel A. Updegrove). Appendices include sample EFPM reports for Carnegie Mellon University and Yale University. (SW)

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Financial Planning Models: Concepts and Case Studies in Colleges and Universities

edited by:
Joe B. Wyatt
James C. Emery
Carolyn P. Landis

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Preface

Laura Bornholdt

Over the past decade Stanford University has enjoyed a well-deserved reputation for the successful development of new procedures for academic planning and budgeting. For most of the same years, the Lilly Endowment has pursued the improvement of management tools for administrators of colleges and universities as a major program objective. Under the leadership of James B. Holderman, then its Vice President for Education and now President of the University of South Carolina, the Endowment recognized the common interests of the foundation and Stanford University in 1974 by making the first of two major grants in support of the work of a team of Stanford analyst-researchers, William F. Massy and David S. P. Hopkins. Together with Stanford's Provost, William F. Miller, Massy and Hopkins had been leaders in the reform of Stanford's planning procedures, a reform well under way in 1974 when they proposed that the Endowment support them in developing and testing a collection of macro planning models. A set of computer models, they argued, could help top administrators at Stanford and elsewhere address basic issues and options related to institutional size, costs, fund management, and quality of instruction.

The second grant was made two years later to enable Massy and Hopkins to recruit other institutions into their modeling laboratory. As described by Joe B. Wyatt in the Introduction, the experiences of Harvard, Lehigh, Pennsylvania, and SUNY Albany in adapting the Stanford models

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led to the development of a more generalized model. In the summer of 1978 the four-year old collaboration of Stanford University and Lilly Endowment was celebrated in a three-day Workshop held in Indianapolis on the topic, *The Application of Financial Planning Models in Colleges and Universities.*

The Workshop brought together top university administrators – presidents, provosts, deans, treasurers, vice-presidents – from institutions large and small, public and private, simple and complex. Middle level university business and financial managers from the same spectrum of institutions were also represented. The final component in the Workshop mix was a substantial number of computer experts from academic and other non-profit organizations.

Some participants were veterans in the use of computer models in an academic context, while others were inexperienced and doubting Thomases. Some lacked any sophistication in computers or modeling, while others were national leaders in the field.

All participants had to ask themselves how a Workshop could succeed in the face of such a complex assortment of participants with so many potentially conflicting personal and institutional agendas. In retrospect, three factors account for the overwhelming success of the conference:

1) There was early consensus that administrators *need* computer experts and vice versa. As the papers in this volume attest, planning university futures remains an art not a science. ("The inescapable fact is that political and tactical considerations are of crucial importance in the initial acceptance of any model." Ottervik) The experienced computer "whiz kids" and the experienced administrators recognized their respective need for one another and often for interpreters or liaisons as well.
2) The admixture of lecture, discussion, case studies, and "hands-on" experience made it possible from the beginning for "sheep" to talk to "goats." Computer experts recognized their own limitations in generating institutional models; complementary intelligences appeared a key part of the process where and when modeling succeeded. (One participant commented that he had never known a conference where even the "leisure time" conversation revolved around the workshop theme.)
3) The modesty of the pioneers – Massy, Hopkins, Wyatt, *et al.* proved persuasive as a hard sell could never have been. "No model is likely to be perfect." "The payoff lies in the process, not in the model." "The whole purpose of a model may be to get consensus and thereby equip a group to work together and to share risks." "The model must never run its designer." "Models can't resolve

conflicts of values." "Models and concepts are transferable only at the very simple level."

Letters of appreciation attested to the value of the Workshop, but the acid test of a successful conference lies in the changes it brings about in the subsequent actions of participants. After six months, there is already ample evidence that the participants in the August Indianapolis conference went home with plans for "selling" the modeling process which they had heard about, seen, and *touched* in the course of the Workshop. Several of the participants took soundings for a collaborative institutional effort which has since taken form under the aegis of EDUCOM. Everyone present agreed that a permanent record of the conference – the principal addresses, the presentations of case studies – would be eminently helpful for themselves, their colleagues back on the campus, and a much larger audience beyond those privileged institutions.

The Endowment shares with the authors the belief that it is too early to predict what may ultimately come out of the Stanford team's work and its dissemination. We do not believe university administrators now have infallible predictors of their institution's future. But we are convinced, as we hope will be readers of this volume, that identification of risks in financial management and of trade-off possibilities and policy options are now within reach of thoughtful administrative teams. It can be a giant step.

Introduction

Joe B. Wyatt

"No amount of planning will ever replace dumb luck." A plaque with this admonition hangs prominently in the office of the Deputy Secretary of the Department of Health, Education and Welfare. Hale Champion brought it with him from Harvard University where he was Financial Vice President for five critical years beginning in 1971 during which Harvard's financial structure, outlook, and planning were changed considerably. Champion is a wiley planner and strategist with considerable skepticism about computer based planning models, and much of that skepticism is based on experience with standardized models for higher education. He also maintains some healthy skepticism about computers and their use in management.

Hale Champion is not alone in his skepticism of both computers and planning models, particularly among college and university executives. A substantial number of today's executives feel less than comfortable with computer output and quantitative methodologies in general. It is fair to say, however, that there are other college and university executives who differ in this view. They find quantitative methods, including computer-based management information systems and computer-based planning methodologies, very comfortable indeed. To some they seem almost indispensable. Both of these conclusions are supported by the findings of a research project undertaken in 1973 with Ford Foundation sponsorship on the relationship between university decision makers and computer-based management information systems.[1] Three additional conclusions from this work are important relative to the issue of computer based planning models in universities:

- Institutions and administrators are diverse and idiosyncratic in their management styles.
- Current computer based information systems are not adaptive to a variety of management styles and skills. They are complex, difficult to change, and not well understood by their users. The information provided is not in a useful form to suit the style of the individual administrator. There is also unresolved and confusing duplication of effort between the computer based information systems and the ad hoc systems of administrators and administrative organizations.
- Instead of directly using computer based information systems outputs, administrators often employ people to act as "information interpreters" in compiling usefully stylized information from the computer based information systems and other sources.

Some of these findings parallel experiences from the private sector in the use of computer-based information systems. Others are more relevant to colleges and universities.

The Planning Milieu

Taking the plaque on Hale Champion's wall to mean that he is adverse to strategic planning is like believing that the stranger who sits down at the poker table and asks if two pair beat three of a kind has seldom played the game. Similarly, the executive whose office overflows with computer output may actually rely much more on qualitative "feel" than on quantitative data when it comes to making critical decisions. But, regardless of the individual style, every university executive has to plan, particularly in today's economic environment. In fact, it is very unlikely that a Board of Trustees or a State Board of Higher Education would allow the absence of some planning methodology that forecasts the economic future for an institution.

The record of planning models, particularly computer based planning models, is spotty at best for university planning. In the private sector, the track record for computer based planning models has been less than spectacular as well. In the words of John F. Hammond III,

> "All has not been sweetness and light with this relatively new tool. Models have proved expensive, many have taken longer than expected to create; their requirements have been extensive and often unrealistic, may have represented business realities improperly and, in general, they have been inflexible. Consequently, management has refused to accept a large number of models or has used them less frequently or in a different manner from the one originally planned."[2]

Hammond's conclusions were drawn from case studies of private cor-

porations in which four corporations were studied in depth and sixty others were surveyed.

The findings described by Hammond from the corporate world have certainly been present in the use of planning models for colleges and universities. Moreover, there are other factors that seem to make the use of computer based planning models in colleges and universities even more difficult.

Heavy Economic Pressure

Few enterprises in the United States face a more bleak economic future than colleges and universities. Expenses are rising at a rate greater than inflation and there is pressure to have them grow even faster. For example, the faculty salaries that constitute most of the universities' expense budgets have, over the past two decades, lost considerable ground relative to other professional and labor categories. The average automobile worker, who in 1958 was paid about half the salary of an assistant professor, is today paid more. Government scientists, on average, are paid more than university scientists. Data of this sort have not escaped the attention of college and university faculty, and, as a result, both informal and formal bargaining to significantly increase salaries is underway in most places. Universities are also vulnerable to several other major economic problems of our society like rising energy costs and food costs, and university libraries face a unique economic crisis as a part of the "information explosion".

On the income side, the supply of students from traditional age groups is dwindling and therefore affecting the prospects for tuition income growth at most institutions. The performance of endowment portfolios has not been spectacular for those private institutions that are significantly affected, and the recent passage of Proposition 13 in California has sent a wave of panic through institutions all over the United States that draw financial support from state taxpayers. At best, the economic future of colleges and universities is clouded with uncertainty, a fact which makes planning both absolutely necessary and extremely difficult.

Heterogeneous Management Styles

If there is any single characteristic that labels universities as being different from almost any other enterprise, it is the diversity and idiosyncracy in the management styles of university executives. Most chief executive officers of universities are drawn from the ranks of the faculty. Humanists, lawyers, physicists, and physicians with a wide variety of administrative experience run today's universities. The management styles among these executives range from very informal to very tight, and, accordingly, the decision making style of these individuals ranges

widely, particularly as it relates to decision support systems. Regardless of background and training, most university executives rely more on a staff of information interpreters, people who supply information for decision making, than they do on computer generated information.

A derivative issue is the characteristic of individual planning style. Much of planning is a personal intellectual activity. Universities, more than other institutions, are managed by a consensus of a large number of individuals. However, this does not change the inherently individualistic character of the planning process as it is practiced by individual executives. In fact, blindly accepting another person's planning methodology or computer based planning model is akin to using another person's toothbrush. It is not done except under extreme circumstances.

Moreover, organizational structure in universities varies as well. At some universities, executive management functions through a concentrated organizational structure with a president and a very small number of vice presidents functioning under the auspices of a small Board of Trustees. Other institutions have both a chancellor and a president, as well as a large number of vice presidents operating under the auspices of more than one Board level. This is particularly true in public institutions that characteristically have, in addition to a Board of Regents, both legislative and executive oversight committees from state government. Last but not least, the political intrastructure at individual universities, both public and private, that so often affects decision making varies substantially from one institution to another. Although everyone recognizes that it is necessary to communicate plans to others, it is often preferable to communicate plans in small increments without explaining widely either the whole plan or the mechanism by which the plan was developed.

Executive Turnover

It is not unusual to find that the executives of an old and established corporation are long time employees. In fact, promotion up the corporate ladder from within is the rule rather than the exception for executive development. Moreover, as an executive moves through the corporate ladder, he or she understudies a position for extensive periods of time becoming familiar with the role and scope of decision making before assuming full responsibility. This process is seldom seen in universities. The difference may stem from department chairpeople who typically serve three year terms and then return to faculty status or otherwise avoid responsibility for the administrative decision-making process. Whether or not it is related to the department chairmen management cycle, very rapid turnover is characteristic of university executives. For example, at Harvard, Stanford, and the University of Pennsylvania, the president and most of the

executive officers have changed in less than a decade. At the State University of New York at Albany (and the State University of New York system) the chief executive officer changed during the two-year term of the Lilly project.

The transience of university executives compounds information problems and exacerbates the difficulty of establishing a regularized planning process because turnover in executive officers is often accompanied by a significant revision in institutional management style. For example, the University of California system under the leadership of Charles Hitch took on a highly centralized decision making style. Policy decisions were reviewed for all campuses of the university system by a central administrative structure supported by an elaborate set of computer-based information systems. However, Hitch's successor, David Saxon, opted for a much more decentralized administrative structure in which the individual campuses make their own policy decisions with more restrained participation from the central administration. It appears that the large-scale computer-based information systems to support centralized decision making are being dismantled.

A studied move toward decentralization of financial responsibility is also taking place at the University of Pennsylvania under Martin Meyerson. Jon Strauss, who is Meyerson's Vice President for Finance and Administration, describes the management decision making environment at Penn in detail in a later chapter of this volume.

Complex Market Structure

Large universities are very complex organizations that operate in a complex marketplace. Individual university departments and schools have widely diverse interests and constituencies. If one considers students as the product of a university, the market is both dismally bleak (for example in education) and bullish (medicine, business, and law). Because of the organizational complexity, the lead time required to develop the capacity to produce students trained in a particular field, and the time required for students to matriculate, universities have significant difficulty in altering their output over the short term. The faculty tenure system also limits the flexibility of universities to alter their product mix over a short period of time. But universities are expected to react to short term societal phenomena. For example, there was a significant need for physicists in the 1950's to which universities responded; a substantial oversupply resulted in the 1960's. Conversely, an oversupply of geologists in the late 1950's switched suddenly to a substantial shortage in the late 1960's. In short, universities are faced with activities that require very long lead times to alter their fundamental function. Yet they are asked to survive in an economic sys-

tem and a marketplace that is fickle from one year to the next. What better justification exists for planning!

OVERVIEW

There are four perspectives described in the succeeding parts of this proceedings. In Part I Massy with the other Stanford developers of the TRADES methodology provide the reader a view of the methodology's conceptual underpinnings. The second perspective (Part II) is provided by a small group of administrators (Zeckhauser, Powell, Ottervik, Strauss, and Shirley) from five different institutions who applied the Stanford conceptual framework independently and in quite different ways. The third perspective (Part III) is provided by one computer expert and two administrators. Daniel Updegrove studied the Stanford methodology, observed carefully the uses to which it was put at the five other institutions, and developed the experimental EFPM, an adaptive compiler-like computer-based representation of the methodology with the purpose of generalized use over a network. Frederick Rogers at Carnegie Mellon University and Jan Ackerman with John Goldin at Yale tested EFPM. The fourth perspective is provided by James Emery, a management scientist (both professor and practitioner) who draws some extensible conclusions from the work. In reading these views of the work, one should keep in mind several hypotheses that were formulated early in the transfer experiment. These hypotheses were gleaned in part from prior work. They were augmented from the conclusions of the research on the relationship between university executives and management information systems conducted in 1974 and 1975 under Ford Foundation sponsorship.[3] Others were added during the formulation of the Lilly sponsored EDUCOM project as a part of discussions with Massy and Hopkins. Finally, they were refined a bit during the early stages of the project as others (Strauss, Shirley, Ottervik, and Emery) began to associate their own ideas and experiences with the problem.

Decision Makers Who Use Models Must Be Involved In Their Development

Probably the first and most ubiquitous hypothesis is that the decision makers who use the results of a planning methodology must be familiar with its objectives and its workings. Similarly, it is crucial for the modeler to know the specific decisions that the model is designed to influence and the variables that will be useful in allowing the decision-maker to test alternative scenarios in policy formulation. The answers to these questions require the modeler and the decision-maker to work together closely. In all of the experiments described in the cases that follow, there was direct interaction between the decision-makers and the modelers during the

process of model development. In most cases, several levels of decision-makers were directly involved.

The corrolary to the hypothesis of involvement is the recognition that the decision-maker and the modeler must communicate effectively. In many cases, the modeler and the manager will have very different backgrounds, skills and interests. When this occurs, it is important that each understand the other's problems. It is also important that each not be confused about the other's role. For example, the modeler is not the decision-maker and the decision-maker should not normally assume that he or she knows more about modeling than the modeler. It is important to note that several of the decision-makers for these experiments also have a background as modelers (Massy and Miller at Stanford, Strauss at Penn, Lewis and Ottervik at Lehigh, Powell at Oberlin, and Wyatt at Harvard).

The involvement hypothesis also extends to the computer technologists. The planning process is individualistic and idiosyncratically people dependent, but computer programming is relatively impersonal. For example, the same computer programmer that develops the computer-based planning model might also be developing a computer program for sorting large files of data. In essence, the modeler should be a person (an interpreter) who understands the decision maker's needs and style as well as the technical requirements for computer-based modeling and computer programming. Decision-makers are often not comfortable with a close interaction to computers, computer models, and computer output. In such cases, the interpreter takes the particularly important role of policy analyst to describe policy alternatives using a variety of data inputs and techniques that may not be totally familiar to all of the decision-makers. If the interpreter correctly understands both the decision environment and the computer-based model, the process can work quite effectively. One danger that was discovered in earlier work but not encountered in this experiment is that an information interpreter who is not well informed about computers can, with an enthusiastic computer programmer, become involved in a cycle of developing more and more complex models "in case the boss asks". Such efforts can become both ineffective and expensive.[4]

At the other end of the spectrum, the decision maker, the modeler, and the programmer may be the same person! James Powell, Vice President and Provost at Oberlin College, performed all three functions in the analysis described in a later chapter. As more executives become computer literate, such scenarios may be less rare; but Powell is, at present, more illustrative of the exception. One of the problems in a small institution is that the different skills of modeler and programmer may simply not be available to a decision maker. Lack of those skills can seriously curtail planning model development.

Data Must Be Representative And Reliable

The second hypothesis is that the data used as model input must be representative of the individual institutional situation that is being modeled and must be understood by both the user of the model and the developer. Contrary to the NCHEMS hypothesis, it is our belief that it is not feasible to develop a standardized set of data elements that is transferable from institution to institution. For example, the data elements that were useful and critical for the model of the Faculty of Arts and Sciences at Harvard are very different from those used by the State University of New York at Albany, and so forth.

An additional part of the data hypothesis is that one must consistently resist the temptation in the development of the model to move to a finer level of data detail. One of the significant dangers in the development of planning models is that, with all the best intentions, the model simply becomes too complex and heavy with data. A practice which seems to work well is to begin with the data in highly aggregated form for the initial model. Subsequent refinements in detail for the aggregated model data are then specifically justified in terms of the need for precision in specific outputs.

One of the other significant hypotheses for the modeling experiment, developed at Harvard, is that the derivation of the data elements required for the models is often as instructive as the outputs of the model itself. For example, in developing the longitudinal data for the Faculty of Arts and Sciences model (a process which was very difficult and the most time consuming portion of the exercise) simple "back of the envelope" analysis produced some interesting financial trends even before the model was completed. The phenomenon is not unlike that experienced with the Program Evaluation and Review Technique (PERT). A principal value of PERT is in the development and understanding of the required relationships between activities and events. The regular cranking-out of changes in the critical path often becomes secondary.

Models Must Have An Executive Godfather

A third hypothesis is that a successful modeling activity must have the support of a key executive who makes it happen – in the vernacular, a "godfather". Case studies of the five institutions that participated in this experiment clearly demonstrate the "godfather" phenomenon. For example, Emmett Fields, the former President of the State University of New York at Albany appointed Robert Shirley as the director of planning and systems. Reporting directly to Fields while developing the planning model, Shirley had direct access to the President on a continual basis as the model developed. Jon Strauss, as Executive Director of the Budget

(and chief modeler) had direct access and support from President Meyerson. At Harvard, the implementation of each model has represented different roles for the decision maker. In the case of the Faculty of Arts and Sciences model, Wyatt and Zeckhauser played the role of modelers for Champion and Rosovsky but managed the development of the model in a very low key and unobtrusive manner. Once Champion and Rosovsky became interested in the information provided by the model, the modeling process was taken seriously by each of their staffs. For the Harvard Library Model and the Buildings and Grounds Model, Wyatt assumed a more direct role as executive godfather. At Oberlin, Powell was both godfather and developer.

Models Must Be Comfortable To Their Users

The fourth hypothesis is a manifestation of the oft-encountered "keep it simple" admonition. In other words, initial planning model efforts should be kept as simple and straightforward as possible and still be meaningful. The simplicity applies to the analytical methodology employed by the model as well as the inputs and outputs. For example, it is very important that the outputs of the model be expressed in familiar and comfortable formats. The use of familiar income and expense categories displayed in a form recognizable by decision makers, even to the style of punctuation, can be important. In one case, expressing an output as a decimal fraction rather than as a percentage had a discomforting effect on a decision-maker who was accustomed to seeing ratios expressed as percentages.

Once the modeling process has achieved a position of usefulness, it is important that it be developed further in simple and understandable increments. A successful initial model usually results in some enthusiasm to deal with more complex and difficult issues. In responding to these needs it is important that giant "leaps of faith" not be required on the part of the user of the model. It should be noted that the absorption rate of complexity for planning models varies from one individual and group to another. For example, the executives at Lehigh were immediately receptive to the move from a basic model to the TRADES methodology. At Harvard, however, the more complex concepts of the TRADES methodology initially met with no success for the Faculty of Arts and Sciences Model with the same executives who found the basic sensitivity analyses quite useful. In general, it seems safe to say that the absorption rate of decision-makers for complexity in models is quite slow. Even at Lehigh where all of the executives are scientists and engineers by training, the TRADES experiment was preceded by several years of using more simple planning models.

Finally, a part of this hypothesis demands that all suggestions for the development of a "comprehensive and all purpose model" should be resisted.[5] Large and incomprehensible computer based management information systems have a terrible track record, and the track record for large and complex planning models is even worse. A rule that seems to function well is that no new parameters or functional relationships be introduced to a model unless they contribute specifically and directly to a desired output that is understood by both the decision-maker and the modeler. Working from a highly aggregated beginning, the planning model can be disaggregated and fleshed out in increments as the need arises.

Results Must Be Communicated With Care

The fifth hypothesis relates to the unbounded expectation/suspicion problem that arises often with the use of computer technology. Planning models are most useful in displaying the outcomes of alternative policy decisions. This usually means that some of the scenarios might be quite extreme in their assumptions, i.e., large jumps in tuition for several years or alternatively no salary growth for an extended period. In the politicized environment of a university, the alternative scenarios can sometimes become interpreted as machiavellian intent, and misinterpretations of model outputs can become fuel for ever-smoldering political issues.

At least two approaches have been successful in dealing with this issue. Harvard's early approach was to operate planning models in a very low-key way among small groups of executives. Alternatives were explored without fanfare. When policy decisions were effected, there was little reference to the fact that the policy may have been influenced by a computer-based model. At Stanford, Penn, Oberlin, and Lehigh, however, the relationship of the computer-based models to the decision-making process was successfully treated with considerably more fanfare from the beginning. Stanford's formal financial report of 1975 featured a detailed description of the planning model and its effect on financial policy at Stanford. At Lehigh and Penn, the financial planning models were the subject of several articles in the student newspaper. Moreover, a version of the financial planning model will be made available for access and experimentation by members of the university community. Stanford, Penn, and Lehigh may have overcome the computer mystique. At Oberlin, Powell believes that the experience of discussing planning and budget issues within the framework of the computer-based model results in improved communication and trust between the trustees, the administration and the faculty. Nevertheless, the problem of exacerbated expectations or suspicions relating to computer-based systems, particularly planning models, have been so pervasive elsewhere that the hypothesis appears justifiable.

Models Can Be Used Defensively

A sixth and final hypothesis looks at the "other side" of model use, defense. In almost any planning exercise, there are advocates for certain policy alternatives. As one might expect from university executives, there is usually also a person willing to take the other side. In these friendly debates between executive colleagues, a model built around each alternative scenario can be most helpful in evaluating the consequences of alternative decisions. Experience indicates that, once a decision is reached, the participants have a better feeling about the decision process and a more realistic expectation of the decision's consequences if a model or models have been used.

But there are other arenas in which university planning decisions are deliberated. A Board of Trustees that is only occasionally involved with the details of university administration can be a source of both support and skepticism. Certainly the correct use of a planning model can help communicate to a board not only a recommended policy but also the alternatives and their consequences. In some cases, strong suggestions for alternatives not evaluated can come from such a board. Use of the model to evaluate such an alternative is a useful and usually well received "defense" on the part of the university's executive officers.

However, many public institutions have a much broader governance structure. In addition to the Board of Trustees, there are also legislative oversight committees, Governor's staffs, and often a state agency responsible for public higher education. From these groups frequently come rather vigorous policy suggestions. Some of these "suggestions" have the effect of law. Using a planning model to evaluate the effects of policies proposed outside the university can be helpful in demonstrating both short-term and long-term effects. The case from the State University of New York at Albany described by Robert Shirley in a later chapter is particularly demonstrative of a model used to take the offensive from what amounts to a defensive position.

These six hypotheses met with a variety of confirmation and contradiction, perhaps suggesting that the only consistent hypothesis is idiosyncratic inconstancy! However, if EFPM is sufficiently adaptable, as the early experiments seem to indicate, it could be useful for financial planning in much the same way that programming languages like BASIC and FORTRAN are useful for a variety of scientific problems. To follow the most pervasive hypothesis, that of the necessity for adaptability of planning instruments to individual management style and setting, EFPM must not sink into the rigid framework of standardized data elements and algorithms of its predecessors.

THE LILLY PROJECTS – AN HISTORIC PERSPECTIVE

This work, all conducted under grants from the Lilly Endowment, consists of the "basic laws of motion", "the transition to equilibrium" and the "financial tradeoff (TRADES)" methodology of William Massy, David Hopkins and Nathan Dichmeyer at Stanford. The basic work combined intellectual ingenuity and economic necessity. Massy, a Stanford Vice President and Professor at the Stanford Business School, Hopkins, a post-doctoral fellow at Stanford, and Dichmeyer, a doctoral student at Stanford, shared an intellectual and research interest in mathematical models and the equilibrium theory of economics. The economic necessity was furnished by Stanford's financial emergencies of the early 1970's. The two forces were combined with the grant from Lilly to initiate a project for the development and refinement of the planning methodology and to experiment with the methodology in an active and receptive university environment at Stanford. For the purposes of this proceedings, four papers have been selected to describe both the methodological development and its application at Stanford. The first states the case for the use of planning models in general.[6] The second relates the use of planning models in long-range budget planning for private colleges and universities. The third paper describes in detail the TRADES methodology, which was the ultimate product of the research and development effort, and its use at Stanford. The final paper concentrates on the use of the model for the management of endowment funds at Stanford. This group of papers will provide a basic understanding of the methodology, its experimental development, and its ad hoc implementation by the authors and originators.

The second group of papers describes the experimental transfer of various stages of the Stanford methodology to a variety of institutional settings. Harvard was the earliest experimentor, implementing the "basic laws of motion" described by a set of relatively simple (and easily understandable) difference equations, beginning in 1974. Oberlin College, through the individual efforts of its Vice President and Provost James Powell, implemented the "transition to equilibrium" equations beginning independently and somewhat later. In 1976, a proposal was made by EDUCOM that the Lilly Endowment support a more formal experiment in the transfer of the methodology to other institutions.[7] Three "new" institutions were selected to participate in the experiment and a new set of modeling efforts dealing with institutional decisions (library and physical plant operations) were initiated at Harvard. The three new institutions were Lehigh, the State University of New York at Albany, and the University of Pennsylvania, each of which represented some institutional characteristics not present at Stanford or Harvard, e.g., little or no endow-

ment, state formula funding. These efforts are described in some detail in the five papers that make up Part II of the Proceedings.

The third effort, one that was both fortuitous and unplanned ("no amount of planning will ever replace . . .") was the development of the EDUCOM Financial Planning Model (EFPM) by Daniel Updegrove. Updegrove, supported by Lilly and EDUCOM, was able to produce an experimental modeling language for use in implementing the Stanford methodology.[8] The EFPM was reviewed by the participants in the project, and through Updegrove's initiative, was tested in uncontaminated environments at Cornell, Yale, and Carnegie-Mellon University. The results were encouraging beyond expectation; this experimental version of the EFPM and results of the first tests are described in Part IV of this volume.

Probably the most important aspect of this work is the lasting effect it might conceivably have on financial planning in higher education. To summarize all of the work in a way that will foster its applicability, James Emery, President of EDUCOM and formerly Professor of Decision Sciences at the Wharton School, completes the proceedings with a concluding chapter.

Footnotes

1. Wyatt and Zeckhauser, 1975.
2. Hammond, 1974.
3. Op. cit.
4. Ibid.
5. Porter, 1978.
6. See the first chapter in part one for a full discussion of the case for planning models.
7. Wyatt, 1976.
8. See the first chapter in part III for a full discussion of the characteristics of the EDUCOM Financial Planning Model developed by Daniel Updegrove.

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I. DEVELOPMENT AND USE OF FINANCIAL PLANNING MODELS – THE STANFORD EXPERIENCE

1

The Case for Planning Models*

William F. Massy, David S. P. Hopkins

> "A college or university does its work through creating an environment calculated to bring about desired characteristics in people and to facilitate scholarly endeavor."[1]

> ". . . When all is said and done the decisions that really count are those made by individual faculty and students in furthering their educational objectives. The goal of the central administration is to provide a stable and predictable financial environment in which the academic process can flourish."[2]

The thesis of this book is that decision models can help achieve these goals. Drawing on our experience at Stanford and the work of others, we hope to show that such models can and should become an integral part of the planning process of colleges and universities. Their application is not limited by type of institution. Wise use of decision models, and the kind of thinking that nurtures them and springs from them, can be as meaningful for the complex research university as for the more easily modeled institution with more homogeneous goals and resources.

We must say at the outset that the use of models has not been greeted with universal acclaim in colleges and universities. There is a legitimate concern that the focus will be on the wrong things, that the quantifiable

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*This paper appears in a forthcoming book, *Planning Models for Colleges and Universities* (Stanford University Press, Stanford CA) 1979. Copyright © 1978 by David S. P. Hopkins and William F. Massy; all rights reserved. Permission to reprint the paper in this volume is gratefully acknowledged.

will drive out the profound, and that the institution will take on too many of the characteristics of a business. These things can happen, but with or without models. The objective of this chapter, and indeed of the book as a whole, is to demonstrate that models which assist university and college administrators in solving immediate problems can be built and that their use is consistent with the conservation of long-run academic values.

WHAT IS A MODEL?

Probably most readers will have heard something about the kinds of models that are used in decision science. A more detailed understanding can be obtained as we proceed to descriptions of actual models and applications. However, it will be helpful at the outset to consider the fundamental nature of models and model building before addressing how they can be used in higher education.

Models may be implicit or explicit. Most decisions are taken on the basis of mental models. A mental model usually is implicit unless the person has taken the time to explicate it very carefully. The process of making a model explicit usually means writing it down in some form: this may be in words, in terms of graphs or geometric representations (schematic or iconic models), by using physical representations (analog models), or by using symbols of one kind or another. Whether the result is implicit or explicit, the process of modeling is one of *synthesizing* known facts, theories, and judgements into a meaningful pattern.[3]

Models are *about* something. That is, they purport to represent an aspect of something that exists, or might exist, in the world. We call the object of a model the reference system.

Thus a given reference system can in principle be represented by many different models, each one being more or less accurate with respect to certain characteristics of the system.

Newly constructed models need to be *verified*, in the sense of demonstrating that their design specifications have been implemented correctly. This is not a trivial matter in most cases. Models also must be *validated* — that is, tested to see that the degree of approximation to the reference system is adequate for the purpose at hand. Validation is a continuing process for most models. One's confidence grows each time the model is used and produces credible results.

Models are designed for a purpose. Sometimes this purpose is the improvement of a specific decision. Alternatively, the objective may be to increase one's understanding about some phenomenon in order to advance scientific knowledge, to aid teaching and learning, or perhaps simply to satisfy curiosity. The degree of approximation that will be acceptable in a model depends upon the purpose for which it is being used. The depend-

ence involves both absolute criteria ("is the model credible?") and judgements about the model's efficacy relative to available alternatives, including mental models. What parts of the reference system to include or not to include in a given modeling effort is very much an art – a matter of good judgement. Putting in either too much or too little may well result in a serious loss of credibility. (We will explain why later in this chapter.) Trying to include too much also will lead to practical difficulties in terms of: mathematical intractability, inordinate demands for data, complexity in computing procedures, and in terms of elapsed time and dollar cost. All things considered, model building is much more an art than a science, though scientific theories and procedures are much used and extremely valuable.

Planning models generally are quantitative in character, though this is by no means necessary. For instance, symbolic logic may be used to describe a qualitative policy statement or a schematic design used to represent information flows or interpersonal interactions. These are explicit models, and indeed they may be processable on a computer, but they do not deal with numbers. However, most decision science models do have numerical quantities as central elements. The problems tend to involve allocating amounts of resources to produce certain kinds of value which, if not inherently quantitative, can be expressed as ordinal functions where one outcome is more or less preferred over another.

Quantitative models form the subject matter of this book. We will be working with costs and revenues, numbers of faculty members and students of different kinds, investment returns, capital budget, and other numerate quantities. But in so doing we intend not to lose track of the qualitative dimension, which in higher education cannot be modeled formally with sufficient richness. The objective is to provide explicit quantitative models to deal with things that implicit mental models often fail to keep track of properly, *and* to learn how to mesh the quantitative models with the decision maker's implicit mental models of the important qualitative factors.

Examples of Models Applied to Higher Education

There is a growing literature about the application of models to higher education. The kit of modeling tools is powerful and getting more so, and though the adequacy of data is a perennial problem, this too is improving. For instance, the many offices of institutional research that have been established during the last decade have done a great deal to search out and process data about their institutions and make it available in meaningful formats that are comparable over time and across academic programs.

Some of the institutional research offices do utilize modeling and more of them should and will do so.

An ambitious program for collecting and comparing data across institutions, the Information Exchange Program (IEP), has been established at the National Center for Higher Education Management Systems (NCHEMS), and other work is going forward at the American Council on Education and under the auspices of the Consortium on Financing Higher Education (COFHE). Sessions on higher education models have been conducted in recent years at the national and international meetings of The Institute of Management Science (TIMS), the Operations Research Society of America (ORSA), and the American Institute for Decision Sciences (AIDS). ORSA and AIDS have established permanent special interest groups dealing with the subject, and publications are beginning to appear in the journals of all three associations.

A provocative statement supporting the use of models in higher education can be found in the 1972 address by Dartmouth President John G. Kemeny entitled, "What Every College President Should Know About Mathematics." Dr. Kemeny is a mathematician. He writes, "The most serious contribution that the mathematician-president can make is the fact that he knows something about model building . . ." Also, "Mathematicians are usually very good at explaining complex mathematical things in fairly simple language to a non-mathematician and that turns out to be a very useful asset to a college president, because you can take a highly complex statement and translate it for the faculty, students, and alumni."[4]

Kemeny cites several examples of simple models that were developed and used during the first several years of his tenure as president of Dartmouth. They represent a good beginning for our survey of modeling in colleges and universities.

i. Faculty appointment and promotion rates. The problem was to study the effect of the proportion of assistant professors reappointed and/or promoted to tenure upon the tenure ratio and the ability of the institution to bring in new blood. (We will consider models like this in Chapter 8.)

ii. Assigning faculty billets to departments. What factors are or should be used to determine how many faculty are needed in each department of the university? Examples of relevant factors include the numbers of students of various types and the characteristics of the instruction process.

iii. Program options for year-around operation. Here the issue was how to design a program of year-around operation for Dartmouth. The result was a finding that, in order to maintain student choice and diversity under year-around operating conditions, the number of courses needed

for graduation should be decreased, and flexibility as to timing of attendance permitted.

iv. Determination of the amount of endowment yield and capital gain that should be spent in a given year. This model dealt with the trade-off between current spending and the need for endowment growth to finance the effects of inflation and future needs for real budget enhancement. (The "spending-saving relationship" is considered in great detail in Chapter 6.)

A number of surveys of model-building for higher education are available. The most comprehensive one is due to Schroeder [1973]. We shall briefly review his work and that of a few others in order to provide a context in which to discuss the case for planning models in higher education. More detailed citations to the literature will be provided in connection with our descriptions of particular types of models.

Schroeder divides the applications of management science to higher education into the following categories: (i) planning, programming, and budgeting systems; (ii) management information systems; (iii) resource allocation models; (iv) models for student planning; (v) faculty staffing models; and (vi) optimization models. He labels the last three categories "mathematical models," but that is not very expressive because the same term can apply to resource allocation models and some aspects of the implementation of PPBS and MIS.

Planning, Programming, and Budgeting Systems (PPBS). This type of work is most easily defined in terms of its name. "Planning refers to the setting of organizational objectives and goals; programming refers to identifying and evaluating programs or alternatives which meet those objectives; and budgeting refers to providing the resources to support the programs. But PPBS is more than just a new method of budgeting; it includes planning and analysis functions as well. The analysis part of PPBS is usually accomplished by the cost-effectiveness approach, which considered the costs and benefits of alternative programs. Such analysis is an integral part of a PPB system."[5]

PPBS work was performed extensively during the late 1960's, with the example and impetus of federal and state government agencies. According to Schroeder, there were "no successful ongoing applications of a comprehensive PPBS" in higher education in 1973, and to our knowledge none have occurred since. However, NCHEMS was developing a standard program classification structure, "so that institutions can have comparable data on costs of programs and to facilitate statewide, regional, and national planning."[6] Zero-base budgeting is now of great interest and has some of the same objectives and characteristics of PPBS, especially when

applied to non-academic and institutional support services. In this book we do not address PPBS or ZBB concepts or procedures as such, though some of our models might be useful in that context.

Management Information Systems (MIS). This refers to the collecting, storing, and retrieving of information for planning and control. Relevant information includes financial and budget data, student enrollments, course demand statistics, employment records, and so on. As of 1973 most integrated systems were in the design stage, with few implementations. Schroeder cites a number of references to specific systems and reviews of systems, and then points out that, "One of the issues in MIS design is the question of how to design the data base. Advocates of the comprehensive approach argue that we should include a large amount of data in the data base since we cannot hope to predict the data which management will need. This type of approach is advocated by Project INFO (at Stanford University). The other approach argues that decision making should be analyzed and analytic models constructed where possible to determine what data should be included in the data base."[7]

Having had some personal experience with the problems of Project INFO, we believe strongly that management information system design should be approached in terms of bite-sized pieces. It is simply too expensive to try to anticipate all management needs, and in many cases the problems of maintaining control over the accuracy, consistency, and timeliness of the data elements in a large integrated system are beyond the limits of feasibility. Model-building can be a very important organizing and prioritizing factor in MIS design. Many of the models we will discuss in this book have significant implication for the design of data bases and MIS reports.

Resource Allocation Models. These models relate the inputs of the educational process to the resources required. They translate enrollment projections into demand for courses, faculty, facilities, and support activities. The required resources are then costed and aggregated for various output reports. The purpose of these models is to simulate the effects of changes in enrollment or in technology (student-teacher ratios, class size, etc.) on the resources required."[8]

The best-known resource allocation models are CAMPUS (Computerized Analytical Methods in Planning University Systems), developed at the University of Toronto, and RRPM (Resource Requirements Prediction Model) that was developed by NCHEMS as an outgrowth of an earlier model by Weathersby.[9] In analyzing RRPM, Hopkins [1971] concludes that, "these models are suitable mainly for making cost-per-student calculations under current operating conditions and it is questionable whether

the expense of building in a large amount of detail for this purpose can be justified." Further discussion of resource allocation models and the development of alternative formulations based on network flows will be provided in Chapter 5.

Models for Student Planning. The work in this category includes scheduling students to classes, enrollment projection, and tracking student flows through an institution. The scheduling problem apparently was attacked first, with one-third of 96 colleges and universities surveyed in 1969 indicating some use of computers for this purpose. Prediction of entering student enrollment involves analyzing and projecting applicant pool size and composition and yield rates. (The latter is the proportion of those admitted to the school who actually matriculate.) Student flow analysis deals with the progression of people through the various levels of the school (e.g. from freshman to sophomore to junior to senior standing), taking account of stopouts, dropouts, repeats, and transfers. Enrollment and student flow projections are important for predicting faculty staffing and other resource needs, tuition income, and in some cases state government appropriations. We will describe a number of different modeling approaches in Chapter 8.

Faculty Staffing Models. The questions here deal with faculty age distributions, tenure ratios, hiring and retirement rates, faculty workload, and the allocation of faculty billets to academic departments and programs. A variety of interesting approaches exist. They also will be considered in Chapter 8.

Optimization Models. This is something of a catchall category since many different kinds of models of a variety of reference structures in higher education can be used as bases for optimization. The term itself means, "finding the set of policies or the resource mix, etc., that maximizes or minimizes some objective." For instance, business firms maximize profits or minimize the cost of producing a given amount of output. Colleges and universities try to maximize over a broader set of values, and also try to minimize the costs of achieving desired outcomes.

Schroeder cites models for allocating faculty time to departmental tasks such as different kinds of teaching and research, determining admission policies for different types and levels of students, and in one case for optimizing the growth trajectories for student enrollments, faculty hires, and facility construction given that there is need for institutional expansion. We will deal with optimization questions as appropriate throughout the book, and particularly in Chapter 9.

Other surveys of models in higher education are provided by Oliver [1972] and Gray [1976]. Oliver adds educational planning models devel-

oped to aid system-wide administrators or government officials to the categories just described. However, the general approach to student and faculty flow modeling and resource allocation and prediction are familiar. Otherwise his categories are not very different from Schroeder's student, faculty, and optimization categories, though some different examples are cited.

Gray's analysis is couched more in terms of modeling methodologies than by type of application. He gives examples of the use of: (i) linear programming, including goal programming, network flows formulated as linear programs, and integer programming; (ii) methods for dealing with uncertainty in terms of probability models, especially Markov chains; (iii) computer simulation models; and (iv) feedback control or cybernetic processes. He also describes some of the problems that must be overcome if efforts at modeling are to be successful. We will make use of some of these techniques in our discussion of specific models and applications, and a central theme of this book is how to design and develop models that will be genuinely useful to decision makers in colleges and universities, that will be perceived as such, and that will actually be used to help solve real and important problems.

We must conclude this survey with a word of caution. To the best of our knowledge there have been no successful efforts to model comprehensively the two most crucial decisions that must be faced by faculties and academic administrators. They are (i) the choice of academic disciplines in which the institution should try to excel and the mix of faculty appointments in particular subdisciplines and specialties that will be needed to attain or maintain eminence; and (ii) the criteria and measures for evaluating individual faculty members for appointment and promotion.

The models dealing with faculty staffing that we cited earlier all deal with aggregate factors such as age distributions, tenure ratios, and hiring and promotion rates, or with gross measures of workload such as student demand, numbers of courses to be taught, and needed allocations for organized research. They do not, and in our opinion cannot, aid in assessing the intellectual promise and intrinsic importance of fields and subfields or the qualifications of individual professors. A special quality in these judgements, cumulated over a long period of time, spells the difference between a good institution and one with a credible claim to excellence.

Effective decision making with respect to the aggregative (and often quantitative) planning factors can provide the necessary conditions for academic excellence – the environment in which teaching and scholarship can flourish. But sufficiency requires, in addition, sensitive and informed judgements of a qualitative kind. That is the essence of outstanding academic leadership.

CONCERNS ABOUT MODELING

The biggest danger in applying quantitative decision models to the planning problems of colleges and universities, and the source of the most concern, is that the process will somehow warp the institution's ability to make the truly fundamental academic and humane judgements. Models easily can leave out important factors (especially ones that are qualitative and intangible) that are crucial for a given decision. The model may pass a narrow test of validity – for example, by adequately representing the formalistic or numerate parts of the reference system, and yet it may be worse than useless.

A related problem is that the mathematical and computer trappings of many decision models, and the attitudes of some model builders, scare away or squeeze the generalist out of modeling and model-validation. This is extremely dangerous, both for getting models implemented and for getting effective ones built in the first place. Professional decision scientists tend, in time, to see the world in modelable terms. It often takes someone who actually is responsible for conserving and enhancing the value of an institution to help determine where models should or should not be used and where simplifying assumptions may safely be made. Special contributions can be made by the humanist. There are some areas of life where the intellectual or rational processes upon which the valid use of a decision model depends should not be allowed to dominate – emotion, love, humor or pathos, satisfaction or frustration call out but a few of these. Colleges and universities treasure the affective as well as the cognitive dimension of life, and this must not be modeled away.

"A little knowledge is a dangerous thing . . ." This is part of the gospel of humility that should be learned by planners, modelers, university officers, and trustees responsible for decision making in colleges and universities. Effective modeling requires some understanding of: (i) what is important for the institution, its constituents, etc.; (ii) what are the relations between means and ends – inputs and outputs in economists' jargon – in terms of achieving these goals. Both are seen but dimly in higher education, due to the multifaceted and sometimes controversial character of goals and the great complexity and subtlety of the processes that transform inputs into outputs.

Doubts arise as to the feasibility of planning *per se* (as well as modeling) in colleges and universities. We again quote Howard Bowen:

> "In view of the existing monumental ignorance, one must raise the question of whether academic planning [or modeling] is possible – in the sense of measuring the means and the ends. The condition of the industry certainly suggests the need for more knowledge about the relation between the resources and technologies employed and the true outcomes in human

> terms. The exploration of these relationships can be seen as the primary task of those who would improve rational planning in higher education. Without adequate knowledge in these areas, which will require decades of research, higher education is in a sense flying blind. It is largely dependent on tradition, intuition, and judgement for guidance in its decision making."[10]

He goes on to say that he is not depreciating tradition, intuition, and judgement, and to point out that we should increase our knowledge about the relationship of decisions and actions to goals.

We agree completely with Bowen's remarks, but the conclusion to be drawn from them is not clear. On the one hand, academic planning and modeling is fraught with difficulties. On the other hand, it may be necessary for the efficient use of increasingly scarce resources and in any case it is being mandated as part of the movement for accountability of college and university administration to governing boards and the political process.

Let us examine the implications of "a little knowledge" more carefully. Here is how we viewed it a few years ago in a talk to university planners about models. This was in the midst of our own attempts to develop and implement meaningful decision models at Stanford University.

> "i. Centralized planning is dangerous because it takes the initiative away from those best able to exercise it — the faculty, department chairmen, and deans of individual schools. There is fear that authority will be exercised by the wrong people. Even if the process is highly participative, the hoops and hurdles of a formal planning process may tend to drive out academic creativity and judgement in a Gresham's Law kind of way.
>
> ii. Detailed and scientific modeling schemes that often are associated with centralized planning will make it difficult for profound but qualitative judgements to make themselves felt. A short quotation illustrates the point:
>
> > The success which this elegant model has had . . . is matched only by its failure to predict correctly the actual course of events — a fine illustration of the . . . maxim that a model is never defeated by facts, however damaging, but only by another model.
>
> This argument takes force from the fact that the most important judgements an academic institution has to make are value-laden and qualitative. Models used indiscriminately represent unfair and undesirable competition.
>
> iii. "Planning doesn't work anyway. We've been planning for five years and look at the mess we're in now!" This view is not necessarily irrational. In a highly uncertain world it may be better to design a control system that relies on prompt response to feedback than to try to pre-program events through detailed planning. In addition, there are real and to some extent justified threats to the credibility of higher education administrators and the planning process they try to lead. An important question is whether imperfect planning leads to more or less stability and predictability of ex-

penditures than periodic reaction to environmental events.

> Other, less reasonable, objections also are raised in opposition to the application of planning principles in higher education. These may stem from an inherent mistrust of administration or administrators, a desire to preserve the status quo by "stonewalling" or "do nothingism," or from simple ignorance or misunderstanding about planning principles or the specific problems facing an institution. Where these are dominant they are hardly a credit to academic values and traditions. However, they should not be confused with the manifestation of differing values and judgements pursued vigorously and in good faith, which make any process of university decision making an intense experience.[11]

The first point dramatizes the accountability problem and introduces the fear that planning will lead to oversimplification and that this, in turn, will distort academic goals and judgements. The second point emphasizes the potential power of a model (or a formal plan for that matter) and the dangers associated with indiscriminant use. The third point has to do both with a substantive (and researchable) question of control theory, and a lament that only so much accuracy or predictability can be expected under the best of circumstances.

"A little knowledge is a dangerous thing" in modeling for colleges and universities because it is possible that people may come to view the objective or quantitative dimensions as the only important ones. This may occur simply because they are easier to plan for and model, or it may be that a disproportionate number of people attracted to modeling tend to think in objective and quantitative terms. Either way, the objective, quantitative, empirical, and formalistic must not be permitted to squeeze out the qualitative, subjective, and intuitive in university planning and decision making. Among other things, this means careful attention to the way in which models are constructed and, in some cases, to the choice of areas where model building should be eschewed. These issues will be considered later in this Chapter and throughout the book.

So, the case for decision models in higher education is not self-evident. But despite the caveats we believe it is convincing. Success depends on building models that are properly tailored to the needs and characteristics of colleges and universities. The potential payoffs for institutions and their constituencies is great, though there are undeniable risks.

From the standpoint of the professional decision scientist, the application of models in colleges and universities is an exciting challenge. Our faith in modeling and our sense of objectivity are both tested. One senses also, correctly we think, that if planning models can be used effectively in higher education they can be used anywhere!

The case for models is integrally bound up with the growing need for more effective planning and control in colleges and universities.[12] Plan-

ning and control are themselves subjects of considerable interest and controversy, so we must consider their antecedents.

PLANNING AND CONTROL

Planning and control have always been important components of higher education administration. During the expansionary years of the fifties and sixties, for instance, administrators and faculty alike were happily involved with planning new academic programs, organizing and developing human resources, and marshalling the financial means needed for growth in size and excellence. No one doubted that planning was helpful – indeed necessary – if these objectives were to be achieved.

Control, too, was considered to be desirable and important in a number of contexts. Control of the quality of faculty appointments and promotions is perhaps the most critical variable in the achievement of long-run academic excellence. Carefully designed systems for hierarchial review exist in many institutions to ensure that proper evidence about research and teaching is obtained and that departmental and school decisions flow reasonably from that evidence and are not conditioned by sympathy, favoritism, or other non-academic considerations. These systems are accepted and indeed defended vigorously by thoughtful faculty as well as by administrators.

Other control systems obviously are necessary as well. Fiduciary control of the university's finances, its accounting system, the handling of cash receipts and disbursement, and the meeting of donor covenants and government regulations are all well rooted in the academic enterprise. So is management control of the institution's administrative and support systems, construction projects, maintenance of physical plant, and so forth. Many of the management control functions are not visible to faculty, but they are essential for the effective operation of the institution nevertheless.

During the last ten years, however, the words planning and control have taken on a more ominous tone in colleges and universities. According to Howard Bowen, this is particularly true when planning problems are couched in quantitative terms, or are associated with approaches developed for use in business firms.:

> "Much of the discussion of planning for higher education today is strongly influenced by the point of view and the jargon of business management. Phrases such as cost-benefit analysis, cost effectiveness, marginal cost analysis, systems analysis, accountability, market research, program budgeting, management by objectives, computerized models for long-range projections, and so forth, are commonplace in the discussions of planning. The underlying assumption is that the techniques and the point of view of business planning are applicable to higher education. Some enthusiasts even argue that the financial problems of higher education would be resolved if

> only it would adopt "sound, hard-headed, rational" business management procedures. This claim surely exaggerates the potential returns from any conceivable managerial technique."[13]

He strikes a very responsive chord when he goes on to say that . . .

> "Educators should scrupulously resist the kind of planning, now being thrust upon them by a multitude of outside pressures, that reduces everything to a few simple numbers. They should insist on looking squarely at the means and ends in human terms."[14]

There are several reasons why the "new" kinds of planning and control, and to a considerable extent the use of decision models, are viewed with alarm. The most obvious and the most valid reason is that some of the techniques that have been highly touted *are* seriously incomplete with respect to academic and human considerations that are important for making decisions. Usually there is no disagreement in these cases between modeler and academic officer or professor about the fact that the model does not represent the reference system very well in one or more important respects. However, there is argument about whether the model has achieved the necessary conditions for usefulness (even though imperfect), or whether it is so far off the mark that any effort to consider its outputs will distort the decision. The same is true for more general methods of planning and control. There is legitimate concern that adoption of some of the approaches about which Bowen is concerned will direct attention to the wrong variables and criteria.

Planning and control systems and decision models are mistrusted and maligned partly because they are unfamiliar. As we noted earlier, there is cause for concern when the assumptions and methods of the planner or model builder are not accessible to the decision maker, who therefore cannot participate in the process of formulatinn and evaluating alternatives. However, if the mistrust is *only* of the unfamiliar, and there are no efforts to meet the planner or modeler half-way in an effort to communicate on important issues, this is not a credit to an institution that prides itself on intellectual objectivity.

Two important reasons why planning and control systems are often mistrusted are: (i) the growth in their popularity has been correlated with, and to some extent caused by, the end of the academic boom and a constricting of the resources available to higher education; and (ii) a good many of them have been imposed from the outside, in the name of accountability, upon a reluctant or defensive institution. These points are worthy of a closer examination.

An overarching contextual fact is that the financial resources available to higher education no longer are adequate to meet the perceived needs of academic officers and faculty members. This condition emerged in the

mid-sixties, following more than twenty years of continuous expansion. Some sense of the magnitude of the boom can be obtained from William Bowen's 1968 study of cost and revenue trends in higher education. Cost per student (funded by available revenues) at the three institutions he studied grew at the rate of 7.5 percent per year during the 1949-66 period.[15] Of this, 2.2 percent represented inflation, perhaps 2 or 2.5 percent was due to real salary growth within the institutions, leaving the remaining 2.5 percent or so as growth of quality and specialization. As Bowen put it:

> "The fact that cost per student has gone up faster than the salary of the typical professor means that, whatever increase in output per man hour has occurred, it has been more than offset by forces making for a more expensive educational product (increasing coverage of specialized fields and an increasing proportion of graduate students being two such forces). Thus, part of the increase in cost per student – perhaps one-third – can be regarded as reflecting the costs of a more elaborate (and presumably more effective) educational product."[16]

To this increase in the cost per student must be added the effect of a fairly steady growth in numbers of students, due to demographic factors and the increasing accessibility and popularity of higher education. A similar trend existed with respect to government sponsored research in colleges and universities.

The forces that led to substantial growth of costs per student during the boom years were not capricious. The effect of inflation (which seems small by today's standards) is obvious. Increased specialization is a natural consequence of the deepening stock of human knowledge. For instance, twenty years ago Stanford University had neither a computer science nor an operations research department while today we have both. But the importance of the Classics Department has not diminished, and Comparative Literature has another two decades of relevant material to compare. This is not to say that fields or specialties never wane and should never be pruned, or that all institutions must excel at all things. However, there can be no doubt that the stock of intellectual capital is continually deepening, just as the stock of physical capital tends to deepen in an economy with growing productivity. Financial investments are needed to create and exploit both stocks.

There is a certain logic behind the real growth of salaries as well; at least to the extent they are keeping up with salaries in other sectors of the economy. University faculty and staff contribute to economy-wide increases in productivity through teaching and research. These productivity gains are reflected over the long run in higher real wages. However, it has proven to be much harder to effect quantitative productivity gains in the labor-intensive processes of teaching and research than in the sectors of

the economy that they benefit. Such gains would require that more students be taught per professor without loss in quality – implying some substitution of parafaculty or capital equipment for direct student-faculty contact. Notwithstanding successes with certain types and levels of students (such as in the open universities) these things are very hard to accomplish consistently and on a large scale. The same is true in research – assistants and equipment help but the most valuable resource is still inside the head of the individual scientist or scholar.

To maintain itself the university must pay market wage rates which increase over time in real terms, despite the fact that it cannot internalize the productivity increases that its people themselves help to make possible. The same conclusion is reached if we approach the matter from the point of view of equity rather than impersonally through labor markets. University faculty and supporting staff help to increase the productivity of other people. It is not unreasonable that they share in the gains regardless of the accident that makes their own "production process" inherently labor intensive. There is an irony here that planning systems and those who provide the resources for colleges and universities should take into account. The more effectively a university performs its work of contributing to productivity in the general economy, the more of an economic disadvantage will have to be overcome.

The academic boom lasted long enough for a whole generation of faculty and administrators to "grow up" professionally without experiencing any significant long-term scarcity of resources. Every effort was being made to achieve *effectiveness*, without wasting resources but without being overly conscious of their limits either. Quality was a great concern. Some schools were striving to increase quality by broadening the resource base while others worked to maintain quality to the greatest degree possible in the face of rapid expansion in the size of the student body. And as so often is the case in boom times and when people are under pressure to achieve results, colleges and universities tended to accumulate "organizational slack," less delicately called "fat."

The cumulative effect of these forces was to condition faculty and administrators to expect their institutions to respond favorably to well-founded requests for academic enhancements. Furthermore, programs that continued to meet reasonable quality standards could be expected to remain on the books. In time, these conditions took on the aura of categorical imperatives.

Thus the end of the boom represented a greater shock to the academic system than otherwise would have been expected. Possibly, too, the fact that the tightening of resources occurred in conjunction with the crises of values and governance of the Vietnam years made the pill harder to swal-

low and inflamed attitudes more than otherwise would have been the case. The net result has been a residue of bitterness and a sense of lost opportunity on the part of many faculty and not a few administrators. Some of this rubs off on proposals for employing new planning and control approaches, including decision models, for managing scarce resources. Somehow the feeling persists that were it not for the new techniques, the degree of scarcity itself would be less severe or the problem not so disruptive.

There were a number of reasons for the decline in resources available to colleges and universities after 1968:

- The trend in the number of students flattened out and in some cases declined as the result of demographic factors and changes in attitudes about going to college.
- Other social priorities such as health, the environment, and the alleviation of poverty through more direct means than education have come to the fore.
- Economic circumstances, including factors like inflation and dislocation of the capital markets, have depressed investment returns, philanthropy, and to some extent government revenues available for education and welfare programs. These effects have not been bad in all recent years, but there has been considerably more difficulty and uncertainty than was the case during the academic boom. There has been a sense of disenchantment with higher education at many political levels and among many segments of the public at large.

The causes of these phenomena are complex and they are beyond the scope of this book. Given the fundamental nature of the underlying phenomena, however, an argument that places the blame for the higher proportion of "no" decisions upon the existence of planning models is badly misplaced.

Higher education has come of age, with the responsibilities as well as the benefits that implies. One of the implications is that five or six percent real growth annually (including two or three percent quality improvement) cannot be sustained over long periods of time given the new conditions and the larger base. Another implication is that society is demanding more effective planning and control systems within colleges and universities. These go beyond traditional fiduciary financial control to strike at the heart of the questions of how planning is accomplished and resources allocated, and how the institution can demonstrate to third parties that this has been done effectively.

Advantage of Models in a University Setting

Often the great advantage of an explicit model of a process involving quantitative dimensions is that the structure of the reasoning process or calculations are laid bare. The same is true of the underlying assumptions and the data or judgements used as inputs. Put another way, conclusions obtained from the planning or decision making process are synthesized from a number – sometimes a large number – of building blocks. Each block can be subjected to scrutiny and if necessary debated, as can the procedures by which the blocks are linked together.

A model achieves credibility when sufficient support emerges with respect to each area of evaluation. Conversely, models can be disproved or discredited if their foundations can be attacked successfully. In an environment that aspires to operate according to intellectual criteria, as is the case for colleges and universities, the process of making one's model explicit and then defending it is fundamentally better than relying upon simple assertion.

Put another way, university planners and decision makers should strive not only to "know" but to understand "why they know." They should be prepared to articulate and if necessary modify their position on important issues as the result of rational discourse. Consultation with faculty, trustees, and students should be viewed as a process of developing and refining judgements, and reaching a collective understanding about the reasons for them.

The use of decision models helps to organize thinking and expose it for rigorous debate. There are enough experts on the faculties of universities so that, with reasonable amounts of effort at communication, the technical aspects of modeling need not stand in the way of its evaluation within the university. (These resources should be sought by the model builder.) It is true that the explication of assumptions may make a person or policy vulnerable to misinterpretation or efforts to discredit – e.g., as under the ground rules of an adversary proceeding.[17] (This is the converse of the proposition that "only a model can defeat another model." Often one defeats a model by discrediting the model builder.) However, the university is a place where the intellectual model of inquiry, with its reverence for the truth even if it hurts, should be particularly cherished. Self-interest and limits to rationality may sometimes undermine the process, but this must be viewed as the exception rather than the rule.

Perhaps not surprisingly, our conclusion is that the wise use of models as an aid to planning is not incompatible with the basic tenets of a university. As we have argued several times by now, the questions of efficacy and compatibility revolve around the nature of the models that are developed and to the ways in which they are used. We do not argue that model-build-

ing cannot go awry, or think that it has not done so on occasion. However, that need not be the expected result. We shall conclude this chapter with a discussion of how models should be constructed and used so as to minimize undesirable side effects.

Some Characteristics of a Good Model

A good explicit model can be defined as one which is used to help develop an important plan or make a decision, and which produces a better result than if intuition and judgement – that is to say, implicit models – had been used exclusively. That is the objective to which we aspire. Clearly, the model must pass a certain test of validity if it is to have any chance of being "good." But that is not a sufficient condition, since it is possible that a valid model will not be used or that it may be used badly. Also, it often is not clear just how the validity test should be applied or interpreted.

The place to start in thinking about the characteristics of a good model is to consider how decision makers use models. The following (perhaps stylized) quotation was published by John D. C. Little in an article entitled "Models and Managers: The Concept of a Decision Calculus." The context is that of an interviewer discussing the implementation of a large-scale linear programming model for scheduling production in an oil refinery with the analyst responsible for the model.

"Interviewer: 'Do you make regular mathematical programming runs for scheduling the refinery?'

Analyst: 'Oh yes.'

Interviewer: 'Do you implement the results?'

Analyst: 'Oh no!'

Interviewer: 'Well, that seems odd. If you don't implement the results, perhaps you should stop making the runs?'

Analyst: 'No. No. We wouldn't want to do that!'

Interviewer: 'Why not?'

Analyst: 'Well, what happens is something like this: I make several computer runs and take them to the plant manager. He is responsible for this whole multi-million dollar plumber's paradise.'

'The plant manager looks at the runs, thinks about them for a while and then sends me back to make more runs.'

'This process continues until, finally, the plant manager screws up enough courage to make a decision.'"[18]

The essential idea is that the manager uses the model as an aid to decision making, but does not let the model "make the decision." Little's paper was about how to affect a meaningful interchange between model and manager through the process of model design. We will return to this presently.

The delegation of responsibility by managers to subordinates provides an analog to the use of models for planning and decision making. There are two polar types of delegation, which for want of better names let us term "line" and "staff" delegation.

1. *Line delegation.* Here the problem (e.g., the decision) is turned over to the subordinate for handling. The delegator's expectation is that the delegatee will be able to handle the issue successfully, though the principal remains available for consultation and is prepared to take back the decision if things appear to be going wrong. (Sometimes elaborate systems for incentive and control are designed to make line delegation work.) Within limits the delegatee's judgement replaces that of the delegator. Evaluation is in terms of the quality of the decision (e.g., in terms of its internal logic, use of data, etc.) and, inevitably, how well things turn out.
2. *Staff delegation.* The decision maker seeks assistance with a problem but does not delegate responsibility to actually make the choice. The staff delegatee may obtain data, do analyses, effect consultations, perform tentative syntheses, and/or recommend alternatives, criteria, etc. However, the delegator retains personal responsibility for the decision – the assistant is in a sense an extension of the person of the delegator, and this is known at the time the assistance is sought.

Obviously the degree of independence enjoyed by the delegatee is in either case a function of the delegator's trust in him or her. However, there is a qualitative difference. In the case of line delegation, the supervisor does not expect to have to come to grips personally with the details of the decision. His role is one of motivator and monitor rather than problem-solver or doer. The need to come to grips with the decision is a signal that the subordinate has failed. This is not the case for staff delegation, where the delegatee's role is to extend the range and effectiveness of the decision maker's judgement – to stretch his or her mind, so to speak.

The kinds of models discussed in this book are candidates for staff delegation but *not* line delegation. This is the case not only for models in higher education, but of policy models generally. The decision maker retains the personal responsibility for choice, and the role of the model and the model builder is to extend his or her judgement.

Probably the reason why policy models cannot be given line delegation is obvious. Their degree of validity (measured in the broadest terms vis a vis the reference structure of the decision) is insufficient to allow the decision maker to get out of the loop intellectually. It is true that there are

cases where models do receive line delegation, but these are in the area of "operations models" as opposed to policy models. A good example is an inventory control model that reorders small items on the basis of current stocks, current or projected demand, and a computerized procedure for determining the optional ordering policy. The differentiating feature of an operations model is that (i) its degree of validity vis a vis the reference structure is relatively easy to verify, and (ii) it is possible to monitor the results of the model's decisions and to intervene with corrective action before things get far enough out of control to generate significant financial or organizational costs. The latter condition tends to apply when the model deals with highly repetitive and routine matters, with no one specific decision being of major importance. However, even under the best of conditions line delegation to models usually meets with a considerable degree of resistance.

We doubt if advances in modeling ever will reach a point where line delegation is feasible for policy issues, where the results of each decision are important and where low-cost and immediate correction on the basis of feedback is not possible. Therefore it is important to choose policy modeling projects and design models so as to maximize their contribution to extending, as opposed to replacing, the judgement of planners and administrators.

It is possible to specify a number of characteristics of models that enhance their ability to perform as mind stretchers. The same factors are important for getting acceptance of models by people who have significant decision-making responsibilities and who may not be technically trained. The model should be:[19]

1. *Simple*. The simpler the model the easier it will be to understand. Understanding the model's fundamental characteristics is essential for use, though of course it is not necessary to master the technical details of a model or its mathematical solution or computer programming techniques. Where the details are complex, a special effort must be made by the modeler to find a way to accurately characterize in simple terms its fundamental properties, including inputs, operating characteristics, and outputs. Our experience is that when models are so complicated that their creator cannot describe their basic tenets in simple terms, there is acute danger that a loss of intellectual control has occurred. There also is much less chance for acceptance of the model by decision makers, and for good reason.

2. *Complete on important issues*. Despite the need for simplicity it is necessary that the model either take into account all the main issues of importance to the decision maker, or be explicit about what is ex-

cluded *and* provide a path for the decision maker to integrate the model's results with his own thinking regarding the excluded factors. The antithesis is where a "simplifying" assumption has been made by the model builder which emasculates an important aspect of the decision, and there is no way for the decision maker to subjectively compensate for this during his use of the model. Models that are judged to be "incomplete" will tend to be rejected or neglected by decision makers. Failure by the model builder to disclose material elements of incompleteness is of course a failure of trust and responsibility that will have a chilling effect on the use of models by that organization in the long run.

3. *Easy to control.* This means that the model's outputs should be more or less predictable, given that its inputs are known. Also, it should be possible to achieve a desired output state, without an unreasonable amount of effort, by manipulating the inputs to the model. Fear is a major deterrent to the adoption of models. This relates in part to whether the model really is complete on important issues, adequately valid, etc. But fear also relates to a potential loss of control of events by the decision maker. (We will have more to say about this later.) A model that is easy to control, ideally by the decision maker himself, will not be as threatening as one that often produces major surprises. (For maximum utility a model's outputs should be surprising, in the sense of producing new insight, but not so surprising as to damage credibility.) Thus, "control" implies that the decision maker (perhaps working with the model builder) has achieved intellectual mastery over the model. The ability to obtain desired output states by adjusting inputs is one way to demonstrate that this degree of mastery has been achieved.

4. *Stable.* A model should never produce non-sense answers given reasonable inputs (well, hardly ever). This is not as easily accomplished as one might think, even for a basically valid model. There may be some pathological cases where the model "blows up." A decision maker will not generally be as tolerant of these conditions as will the professional model-builder. His or her confidence in the model will be shaken disproportionately by "blow-ups," especially if they should happen to occur early in the process of gaining experience with the model. Face validity is important and this tends to be undermined if the model is unstable. Achieving a sense of intellectual control over the model is harder if the model is not stable though of course stability is not a sufficient condition for control.

5. *Adaptive.* This is related to the "completeness" and "simplicity"

criteria. The model should be flexible enough to respond to the changing needs or point of view of the decision maker. "Take-it-or-leave-it" models invite the null response. The decision maker must integrate his or her own thinking with results from the model. The more adaptive the model the easier this task will be, and the less the model-builder will have to anticipate all possible considerations. Also, an adaptive model will seem to be, and probably will be, easier for the decision maker to control. It will be more "his" model, and hence more credible and usable.

6. *Easy to communicate with.* Models that are awkward to use tend not to get used. This is more a matter of the design of the interface between model and decision maker than it is of the structure of the model per se, though some structures are inherently easier to deal with than others. Careful attention to ways in which data are input, tested for internal consistency, and saved for future use or modification between runs pays dividends in terms of people's learning processes and later model usage. The same is true of outputs: appropriate summary results in easy-to-read format (including graphics if possible) as opposed to large stacks of blue-bar paper may well spell the difference between success and failure. This principle follows from the economic maxim that the lower the cost of something the more of it will be bought. Since the time and energy of the decision maker and his staff are limited, the degree of difficulty of communicating with the model is an important element in the cost function.

It is clear that, taken to an extreme, some of the criteria for a good model are mutually inconsistent. This is particularly true with respect to completeness and stability, on the one hand, and simplicity and controllability on the other. However, models that affect reasonable compromises among these criteria have been built and are being used. Finding such compromises is a very important part of the modeling art.

In our judgement many of the models that have been proposed for colleges and universities, and some that are being used, are seriously deficient with respect to one or more of the above criteria. The very large models for academic resource allocation such as CAMPUS and RRPM are not complete on important issues when applied to complex research universities, since they do not consider quality-of-education variables or the joint product character of graduate education and research. Also, the fact that they require thousands of input coefficients make them very difficult to control, not very adaptive, and hard to communicate with.[20] (However, we believe they do meet our "simplicity" criterion since, despite their technical complexity, the basic concepts involved are easy enough to ex-

plain and understand.) We will have more to say about the characteristics of these and other models in later chapters.

Footnotes

1. H. R. Bowen [1977], p. 2.
2. W. F. Massy [1974] 1, p. 6.
3. For a highly readable discussion of this material, see M. Greenberger, M. A. Crenson, and B. L. Crissey [1976], Chapter 3.
4. J. G. Kemeny [1972], p. 2.
5. R. G. Schroeder [1973], p. 896.
6. Ibid., p. 896.
7. Ibid., p. 897-8. Project INFO was later discontinued.
8. Ibid., p. 898.
9. For references on CAMPUS, see R. W. Judy [1969]. An overview of RRPM can be found in W. W. Gulko [1971], and detailed materials are available from NCHEMS.
10. Bowen, op. cit., p. 3.
11. Massy [1975], p. 1.
12. Our use of the word "control" refers to follow-up and evaluation in relation to earlier objectives and plans. "Control" does *not* in the least suggest the abridging of academic freedom, which we consider to be inviolate!
13. H. R. Bowen [1977], p. 1.
14. Ibid., p. 2.
15. W. G. Bowen [1968], pp. 20-21. The three schools are Chicago, Princeton, and Vanderbilt.
16. Ibid., p. 21.
17. See Greenberger, Crenson and Crissy [1976] for a good discussion of these changes.
18. J. D. C. Little [1970], p. B-468.
19. The terms in the list and many of the basic ideas are due to Little [1970]. However, we have freely interspersed our own thoughts with his.
20. See Hopkins [1971], p. 471.

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2

Long-Range Budget Planning in Private Colleges and Universities

David S. P. Hopkins, William F. Massy

Financial stringencies have been imposing an increasingly heavy burden on most postsecondary educational institutions, forcing them to manage their resources more carefully. In the course of achieving better control over budget growth, they have learned much about the forces that bear continually upon the income and expense sides of an operating budget. Computer models have been instrumental both in revealing the nature of these forces and in specifying the hard choices that must be made to maintain the institution's long-term financial well-being.

The purpose of this paper is to show how the use of mathematical models has enabled one institution, namely Stanford University, to enhance its ability to do long-range budget planning. It should be obvious that, under current financial conditions, it is no longer sensible for an institution like Stanford to make top-level budget decisions on the basis of their impact on a single year's income or expense. Attention also must be paid to underlying growth rates that may continually act to drive income and expense apart. Thus, we tend to evaluate such decisions in terms of

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their long-run consequences for financial stability, and we find that the most useful tools are those that represent budgeting in a multiyear context.

Since the models to be discussed here have been designed to assist in top-level decision making, they are formulated in terms of quite aggregate budget variables (for example, total faculty salaries, library acquisition costs, student financial aid, tuition income), unlike many models developed earlier for university resource planning by such organizations as the National Center for Higher Education Management Systems (NCHEMS). The Resource Requirements Prediction Model (Clark and others, 1973) of NCHEMS and the CAMPUS model (Judy, 1969) of SRG generally are used to predict the resource requirements of fairly small units (either single academic departments or small groups of departments), and so they involve a large number of variables and parameters (often as many as several hundred or thousands). Consequently, an institution that wishes to employ such a model usually must engage in a costly and time-consuming effort to obtain all of the requisite data. Models of this type are discussed in greater detail in Hopkins (1971) and Ploude (1976, pp. 17-34).

Other less ambitious efforts at developing financial projection tools for college and university planning are represented by SEARCH (Keane and Daniel, 1970), and PLANTRAN (Midwest Research Institute, 1972). These work with fewer variables and, hence, do not require such large quantities of data. Their usefulness is often limited, however, by a lack of sufficient structure to model the feedbacks that generally affect an institution's budget when certain variables are changed. For example, if tuition rises faster than family incomes are growing, the college can expect an increased need for student financial aid. Unless this effect is properly incorporated in the structure of the projection model, one risks making projections of tuition income and financial aid budgets that are mutually inconsistent.

The underlying structure of the models described below should be applicable to a large number of postsecondary educational institutions. And furthermore, it is easily modified to fit many special circumstances, in part because we use aggregate variables and financial parameters that are common to most such institutions. For several reasons, however, the analysis is chiefly applicable to those institutions that are privately financed. In particular, we assume that both expenses and income are highly controlled, or at least very predictable. Also, the models stress the important role that can be played by an endowment.

Before proceeding to the details of the analytical tools themselves, one further precautionary note is in order. Computer models like these have played an important part in portraying and quantifying financial

tradeoffs among major planning variables. In this way, they certainly have contributed to more informed decision making. They have not been designed, however, to replace human judgment in assessing *all* of the information available to a decision maker before he makes up his mind on a single most preferred action. Viewed in this context, the contributions of quantitative analysis, while essential, are yet but a small component of the total set of considerations entering a decision. This point has been made many times before, but it seems worth making again in order to provide a proper perspective on the use of modeling in college and university management.

THE LONG-RANGE FINANCIAL FORECAST

The first model developed at Stanford for multiyear budget planning was the Long-Range Financial Forecast (LRFF)*. It is simply a device for measuring the implications of current estimates of future income and cost-rise parameters for the university's operating budget. The following procedure is used in preparing the LRFF. One starts by arraying the various income and expense items in the budget in categories whose rates of growth or decline can be judged over the next several years. Tables 1 and 2 show the relevant categories for Stanford.

Consider as an example the first line in Table 1, which represents tuition income. This is the product of the tuition rate in each future year and the expected FTE enrollment. Presumably, judgments about future increases in the tuition rate and enrollment levels are best made centrally (that is, at the top levels of the administration), as are judgments about faculty size and average salary increases. (The planning assumptions for this LRFF were that the numbers of students, faculty members, and staff members would all remain fixed at their 1974-75 levels. Faculty salaries were separated from those of the staff ("other personnel"), to reflect the fact that Stanford competes in quite different labor markets for the two types of personnel.) Other items, such as library acquisitions and utilities costs, are best estimated by line managers who are closest to that particular category of expenditure or income. Thus, putting together an LRFF is essentially a bottom up procedure: those persons who know the most about a given category are asked to use their judgment to state how future conditions are likely to affect that line in the operating budget. As Table 2 shows, the responses reflect a great number of special factors and hence generally do not follow a simple trend over the five years. We have found it helpful to introduce a common set of estimated basic economic pa-

*This model was developed chiefly by Larry S. Owen of the Office of Management and Financial Planning in collaboration with Kent R. Peterson, director of that office.

TABLE I

Operating Budget Long Range Forecast
INCOME
(in thousands of dollars)

	Estimated 1974-75 Budget Base	Forecast Increase 1975-76	1976-77	1977-78	1978-79	1979-80	Estimated 1979-80 Budget Base	Income Trend Rate
Tuition and Fees	$35,689	$3,362	$3,924	$3,935	$4,231	$4,077	$55,038	9.2%
Unrestricted Endowment Income:								
Pools	5,549	(329)	62	60	37	57	5,256	(.9)
Specific Investment	929	15					944	.3
Amortization of Leases	900						900	
Net Annual Rentals	(50)	80	(10)	(30)	(20)	(20)	(50)	
	7,328	(434)	52	30	37	37	7,050	(.6)
Restricted Endowment Income:								
Pools	2,791	(310)	183	173	139	167	3,153	2.5
Designated	11	(1)		1		1	12	1.8
	2,792	(311)	183	174	139	168	3,165	2.5
Unrestricted Gifts:								
Unrestricted	1,800	(140)	100	100	110	110	2,080	2.9
Ford Engineering	28	(28)					-	
Overhead on Non-Govt. Grants	173	10	10	10	10	10	223	5.2
	2,001	(158)	10	110	120	120	2,303	2.8

TABLE 1 (Con't)

	Estimated 1974-75 Budget Base	Percent Increase					Estimated 1979-80 Budget Base	Income Trend Rate
		1975-76	1976-77	1977-78	1978-79	1979-80		
Restricted Gifts	1,014	71	76	81	86	86	1,414	6.9
Special Funds	346	33	33	38	41	40	536	9.2
Other Income:								
Expendable Funds Pool	1,466	(180)	(20)	(20)	(20)	(20)	1,206	(3.8)
SRI	609	76	31	32	34	35	817	6.5
Security Loans	110						110	
Other	939	(51)	76	26	26	26	992	1.1
	3,124	(155)	37	38	40	41	3,125	–
Reimbursed Indirect Costs	12,801	429	440	775	850	985	16,280	4.9
Transfer to Plant	(1,000)	(400)	(140)	(154)	(160)	(186)	(2,049)	15.4
Miscellaneous Income	90						90	
Budget Savings and Income Improvement	250						250	
Total Income	$64,235	$2,437	$4,720	$5,027	$5,415	$5,368	$87,202	6.3%

Note: All figures exclude expenses in the "formula schools" (Business and Medicine) at Stanford which are chiefly responsible for meeting their needs from their own resources.

TABLE 2
Operating Budget Long Range Forecast
EXPENSE
(in thousands of dollars)

	Estimated 1974-75 Budget Base	Forecast Increase 1975-76	1976-77	1977-78	1978-79	1979-80	Estimated 1979-80 Budget Base	Expenditure Trend Rate
Faculty Salaries	$15,138	$ 1,060	$ 1,134	$ 1,213	$ 1,298	$ 1,290	$ 21,133	6.9%
Other Teaching	831	58	62	67	71	71	1,160	6.9
Other Personnel	21,949	2,214	2,159	1,826	1,813	1,929	31,890	7.8
Teaching Assistants	1,166	93	76	73	78	39	1,545	5.8
Salary Requisitions	785	63	51	51	52	40	1,040	5.8
Total Salaries	39,869	3,488	3,482	3,230	3,312	3,389	56,768	7.3
Staff Benefits	6,778	1,026	1,095	1,114	1,197	1,279	12,489	13.0
Total Salaries and Staff Benefits	46,647	4,514	4,577	4,344	4,509	4,668	69,257	8.2
Library Acquisitions	1,945	253	286	322	365	412	3,583	13.0
Undergrad Aid (Unrestricted)	1,941	592	627	823	881	673	5,537	23.3
Grad Aid (Unrestricted)	1,535	160	164	169	174	176	2,378	9.2
Student Health	1,138	114	123	131	143	140	1,791	9.5
Building Maintenance	877	74	87	76	75	81	1,270	7.7
Utilities	1,863	197	153	134	119	124	2,590	6.8
Grounds	526	44	52	45	45	48	760	7.6
Custodial	1,353	114	133	117	115	125	1,937	7.7

TABLE 3 (Con'd)

	Estimated 1976-77 Budget Base	Forecast Increase 1975-76	1976-77	1977-78	1978-79	1979-80	Estimated 1979-80 Budget Base	Expenditure Trend Rate
Equipment	399	32	30	23	19	15	518	5.4
Travel	907	63	68	62	66	70	1,236	6.4
Materials and Supplies	6,668	400	353	297	309	201	8,308	4.5
Other	3,423	205	145	151	157	143	4,224	4.3
Charge-outs	(4,987)	(537)	(445)	(417)	(424)	(429)	(7,239)	7.7
Total Maintenance	64,235	6,225	6,355	6,277	6,553	6,527	96,170	8.7
Improvements and Consolidations		1,734	2,111	2,499	2,941	3,379	12,664	
Operations and Maintenance on New Buildings		200	118	633	164	76	1,191	
Expenditures	64,235	8,159	8,584	9,407	9,658	9,982	110,025	11.4
Income	64,235	2,437	4,720	5,027	5,415	5,368	87,202	6.3
Incremental GAP		$ (5,722)	$ (3,864)	$ (4,380)	$ (4,243)	$ (4,614)	$(22,823)	5.1%
Total GAP in the year indicated		$ (5,722)	$ (9,586)	$(13,966)	$(18,209)	$(22,823)		

Note: All figures exclude expenses in the "formula schools" (Business and Medicine) at Stanford which are chiefly responsible for meeting their needs from their own resources.

rameters, such as inflation (CPI) and wage rates in the economy as a whole, into all of these discussions, so that each individual's response will be based on the same underlying economic assumptions. These assumptions are developed by the central administration with the assistance of outside economists.

The lines labeled Improvements and Consolidations and Operations and Maintenance on New Buildings in Table 2 deserve special mention. These final two categories of expense are used to capture all of the net incremental growth in the budget that exceeds the ordinary cost-rise on the prior year's activities. That is, when all of the items appearing above these lines in Table 2 are summed, one obtains the total maintenance expense. Increases across this line merely represent the amount of the anticipated cost-rise on programs and activities that were already in effect in the base year. In other words, these figures establish the university's internal inflation rate. Additional needs for "funded improvement" in excess of ordinary cost rise are shown on the lines below. Improvements and Consolidations includes all provisions for new programs and activities on a net basis, that is, above and beyond the level that can be funded by reallocating money already in the initial budget base. Operations and Maintenance on New Buildings is separated from other types of improvement to emphasize the role played by capital improvement programs that have already been approved. We refer to the sum of these two categories, expressed as a fraction of the prior year's total operating budget, as the *net consolidation and improvement factor* and we denote it by the symbol f. This has come to be viewed as a major policy variable in Stanford's budget planning process. Its critical role will become more evident in a later section of this paper.[1] In preparing the LRFF shown in Tables 1 and 2, a value of 2.7 percent was assigned to f, which corresponds to its average actual value at Stanford during the preceding three years.

Were it not for certain important feedback elements that link together various components of the operating budget, once one had obtained a complete set of growth rates it would be a simple matter to project each income and expense to obtain the LRFF. This projection could even be done by hand, although it would still be advisable to have a flexible computer program available for testing possible future budgets. Since most institutions have by now stopped considering just one budget plan, one important use of an LRFF is as a financial projection model that can stimulate the effects of alternative assumptions about future elements of income and cost-rise on the operating budget. For example, the Stanford LRFF has been used to test different tuition and salary growth policies and also to examine various assumptions about exogenous factors such as energy costs.

An even more compelling argument for the development of a computerized LRFF is that whatever significant dependencies are known to exist in the system among certain of the income and expense variables should be properly taken into account when making projections. Thus, an institution should determine the nature of the links and feedbacks that characterize its own situation and build these into the program for doing financial projections. At Stanford, we have incorporated a feedback structure in the LRFF program in these three areas:

1. *Student Aid Expense.* Changes in the enrollment or tuition rate affect the expense side of the budget through the financial aid program. For undergraduates, aid is based on each student's financial need, and this in turn depends on his or her family's economic circumstances and the availability of outside assistance (such as that provided by state scholarship programs), as well as on the tuition rate. The model takes these sources into account in deriving the total amount of university aid money required. This is then divided up into loan and job aid, restricted scholarships, and unrestricted scholarships (the only component that appears in the operating budget) according to policy assumptions and the availability of money restricted to undergraduate scholarships. At the graduate level, where aid is not based primarily on need, a much simpler model is used: a weighted average of the tuition growth rate and the CPI forms the estimated growth rate for this line in the LRFF when graduate enrollment is assumed to remain fixed.

2. *Indirect Cost Recovery.* This item represents the reimbursement of indirect (that is, overhead) costs by sponsored research programs. (We should note in passing that the *direct* costs of sponsored research are carried outside of the operating budget and thus do not appear directly in the output from the LRFF.) Under an agreement with the federal government, certain items of expense (most of which *do* appear in the operating budget) have been identified as belonging to one or another overhead category, or "cost-pool." Detailed accounting rules exist for determining the share of each pool that is reimbursable from sponsored programs. To a first approximation, these shares can be represented as being proportional to the direct cost mix between sponsored research and instruction. Since Stanford depends on this source for approximately 22 percent of its operating (that is, nonendowment) income, it is important to model the effects of changes in cost-pools on the associated revenue. Thus, we have incorporated in the LRFF program exogenously specified growth rates for the direct costs of research. These are used along with the growth rates of the direct costs of instruction and the indirect cost-pools, which depend on the growth in budgeted expenses, to project the overhead recovery line.

3. *Endowment.* Since Stanford depends on payout from its endow-

ment to support some 13 percent of its operating budget, the LRFF must be able to track this item explicitly over the five-year period. This program contains equations for projecting the market value of endowment based upon (a) the starting value, (b) an assumed rate of total return from investment, (c) a projection of expected gifts for endowment during the forecast period, and (d) a payout rate expressed as a fraction of the market value at the beginning of the year. In addition, it is assumed that deficits (labeled "Total GAP" in Table 2) must be funded out of funds functioning as endowment. This feedback effect is included in the accounting equations that describe the evolution of the endowment.

Other structural relationships that probably should be taken into account in many other institutions are:

4. *Price Elasticity of Enrollment.* Any institution which accepts all qualified applicants for admission can be said to be demand-constrained. In such a case, rapid increases in tuition are likely to have a depressing effect on the demand for admission and hence enrollment. Estimates of the price elasticity of demand should be made and a student demand equation inserted in the LRFF program.

5. *Student/Faculty Ratios.* If the level or mix of student enrollments is changing rapidly, some effort must be made to model its effect on the faculty size. This may be best accomplished by judgmentally determining appropriate faculty numbers to match anticipated enrollments for the forecast period and putting these directly into the LRFF program. Alternatively, the program can be used to calculate faculty size using prespecified ratios of faculty members to students.

As described above, a computerized LRFF can provide an invaluable tool for projecting the effects of current budget decisions for a period of several years. It has its limitations as well, however. These stem from the fact that it is used primarily to make strictly *uncontrolled* projections of operating budget income and expenses. That is, the LRFF program embodies no predetermined decision rules for dealing with projected income gaps, nor does it allow for modifications of the overall cost-rise that result from internal budget reallocations.

The extent of these limitations was made clear at Stanford in the fall of 1974 when we were faced with the results displayed on the bottom line of Table 2. These figures showed that, in the absence of any corrective action by the university administration, a gap between income and expense would develop immediately and would grow to something like $23 million, or 21 percent of the operating budget, by the end of the forecast period. Obviously, corrective action was essential, but this required the development of more powerful analytical tools that could identify what portion of the problem was due to a fundamental imbalance between the

initial *levels* of income and expense and what portion was due to an imbalance between the *growth rates* of the two sides of the operating budget.

To illustrate the importance of distinguishing between base-level gaps and growth-rate gaps, we present the following simple hypothetical examples. Suppose, in the first case, that current income and current expense are both equal to $50 million, but that the expense growth rate during the next five years is projected to be 7 percent per year while income is projected to grow at only 5 percent. The consequences of this 2 percent rate gap are shown in Figure 1, where this case corresponds to the "A" curve for expenses. We see there that the budget which started out in balance is in deficit by about $6.3 million five years later.

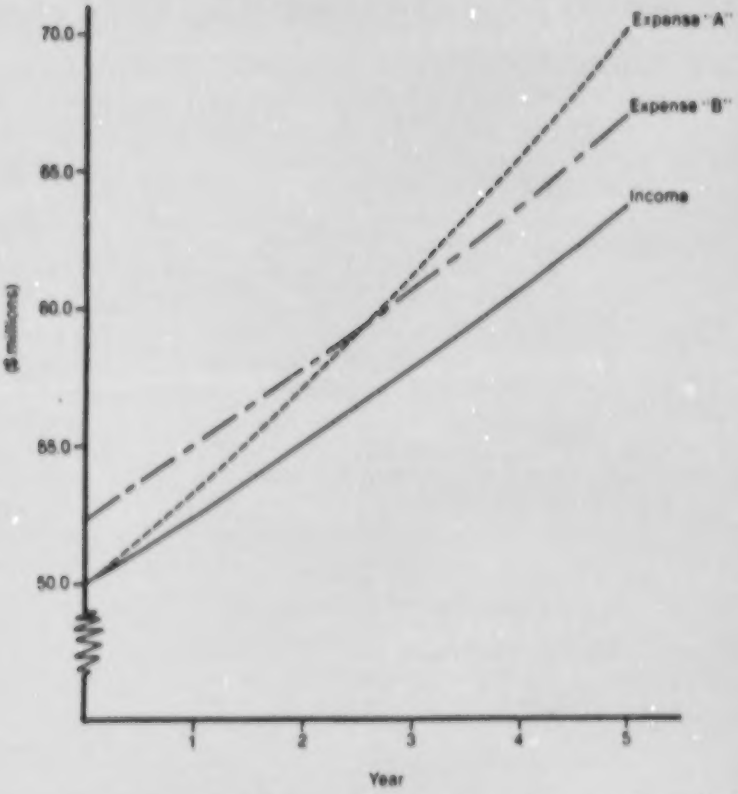
In the second case, we assume that the initial expenses are $52.5 million, so that the budget starts out with a $2.5 million deficit, but that the growth rates of income and expense are each 5 percent per year. This leads to the situation shown by comparing the income curve with expense curve "B" in Figure 1, from which it can be seen that the fifth-year deficit is running about $3.2 million, which is just about half the result in the first case. As this illustration helps to show, rate problems tend to be far more insidious than level problems when they are sustained for even a few years. Moreover, the remedies for the two types of problems are different, for there is *no* one-time adjustment in income and expense levels than can compensate for a chronic imbalance between growth rates.

MODELS OF DYNAMIC BUDGET EQUILIBRIUM

In 1974, we had reason to believe that the Stanford operating budget was subject to imbalances of both kinds. On the surface, Tables 1 and 2 seem to show that there was no income-expense gap in the 1974-75 budget base. After all, the budgeted levels of income and expense are shown to be perfectly balanced on the bottom line. This balance was achieved however, by budgeting a payout from the endowment of $8.3 million (line 2 plus line 7 in Table 1), which represented a hefty 7.5 percent of the then-current endowment market value. We had to question whether this level of spending could be increased to keep up with the rate of cost-rise in the expense budget. If not, some reduction in the payout rate would be necessary, and this would of necessity require a downward adjustment in total expense.

To aid in addressing questions such as these, and to enable us to analyze financial tradeoffs under long-run economic assumptions, we developed difference equation models for tracking the university's operating budget between consecutive points in time (Massy, 1976). These models were constructed to describe the conditions required for a long-run financial equilibrium in terms of aggregate level and growth-rate variables. They

Figure 1. An Illustration of Budget Disequilibrium



could be used to identify feasible strategies for achieving and maintaining a balanced budget over a prolonged period of time, after an institution had leveled off in terms of its student body, faculty, and staff size. (In today's terminology such an institution would be described as having reached the "steady-state." We believe this term to be somewhat inappropriate, however, since innovation and improvement are continually necessary in any educational enterprise, even when budget growth is limited simply to an inflation rate. Such needs will be accommodated, first, by reallocating support from lower priority to higher priority programs, and, second, whenever growth in income will permit, by providing some new money for consolidations and improvements in each year's budget, that is $f > 0$.)

The basic formulation is easy to derive once one has defined the appropriate variables. Suppose we take the following set of *level variables*:

B = budgeted expenditures
I = budgeted operating income (that is, from all sources but endowment)
E = endowment market value
u = fraction of operating income derived from tuition
v = fraction of expenditures budgeted for student aid

and the following set of *long-run rate variables*:

dT = growth rate of tuition
f = net consolidations and improvement factor
r_o = cost-rise factor (other than for student aid)
i_o = income-rise factor (other than from tuition)
g = total return plus gifts rate on endowment
p = endowment payout rate.

A few comments concerning this limited set of aggregate budget variables are in order. In the first place, we note that the year to which they refer is unspecified; depending on the analysis that is desired, it may be the current year, or sometime in the future. Second, we view B, I, E, dT, f, and p to be the policy planning variables and the others to be parameters chiefly determined by forces outside the institution's control. In particular, u and v are simply data (or projections of data) for the year for which we are doing this planning, while g is an estimate combining the long-run expected rate of return from investments in the capital markets and the average results of fund-raising programs (new gifts expressed as a fraction of endowment market value). Finally, we should point out that the cost- and income-rise factors, r_o and i_o, correspond to the growth rates of "maintenance expense" and operating income items, respectively, in the LRFF. They can be obtained by estimating the long-run growth rate of each line in the LRFF, based on general economic assumptions (for example, university salaries will grow at the wage rate in the economy as a whole, which is roughly two to three percentage points higher than the rate of inflation), and then weighting each term by its proportion of the total to get the overall rates. This observation reveals an important side benefit to be derived from preparing an LRFF, namely that it facilitates the construction of cost and income indices for use in longer-range budget planning.

Before we proceed to the budget model formulation, it is convenient to introduce notation for the total income- and cost-rise rates that include the growth in tuition, student aid, and consolidations and improvements. Let i and r denote these rates which apply to I and B, respectively. They

can be obtained in terms of the variables already defined by means of the equations:

$$(1)\ i = (1-u)i_0 + u\,dT, \text{ and}$$
$$(2)\ r = (1-v)r_0 + v\,dT + f\ .$$

(Note the use of the assumption that student enrollment is to remain constant at whatever level is implicit in the base year variables, B and I, in writing these equations.)

Two conditions define (first-order) *long-run financial equilibrium* (LRFE). First, the budget must be balanced, with total expenditures equal to the sum of operating income and income (payout) from the endowment:

$$(3)\ B = I + pE\ .$$

Second, the one-year growth in the budget must also be in balance; that is, incremental expenditures must equal incremental operating income plus incremental endowment income:

$$(4)\ rB = iI + p(g-p)E\ .$$

(Note that the increase in endowment income equals the payout rate times the increase in endowment value, which in turn is derived from investment return and new gifts minus the previous year's payout.)

Any solution in terms of B, I, E, r, i, and p that satisfies (3) and (4) meets the conditions for LRFE. It is easy to see that there are a great many such solutions from the fact that we have only two equations in six unknowns. Thus, a very simple concept leads to a solution set that is rich in possibilities. We have found it generally most useful to fix some of the variables at their current, or other specified, values and then to solve for the others. For example, using actual Stanford data, we have examined tradeoffs between pairs of variables such as B and p, parameterized in terms of a third variable, such as I (Massy and Hopkins, 1973). With E, r, and i fixed, the calculation showed the feasible point for B and p corresponding to each given value of I. This and other, similar analyses have revealed that whenever the payout rate, p, is taken as fixed, feasible options in terms of whatever variables one is considering to be free are quite limited. Thus, we have concluded that, for Stanford, it is almost essential that we treat p as a dependent variable rather than assigning it an arbitrary value corresponding, say, to the actual yield (interest and dividends) obtained on the endowment.

One of the tradeoffs we have found most critical in central budget planning is between tuition growth (dT) and the consolidations and improvement factor (f). It is obtained by substituting the expressions in (1) and (2) for i and r, respectively, and then solving (3) and (4) for dT and f

in terms of the other variables. Figure 2 shows the feasible options that were calculated for Stanford in 1974. Only points within the narrow shaded band were found to be sustainable over the long run. This exhibit received wide attention at Stanford, for it illustrated rather forcefully the harsh realities seen to be facing us in the foreseeable future. If tuition

Figure 2. Trade-offs Between Tuition Growth Rate and Funded Improvement Fraction

Points in this region are not feasible
Boundary condition based on points of discontinuity
Alternatives based on holding constant the fraction of the budget supported by endowment
Alternatives based on the current budget and operating income
Assumed personal income rate (7.1%)
Assumed inflation rate (5%)
Points in the shaded region are achievable through one time budget cuts and/or operating income hikes
A
Growth rate of tuition (dT) (percent per year)

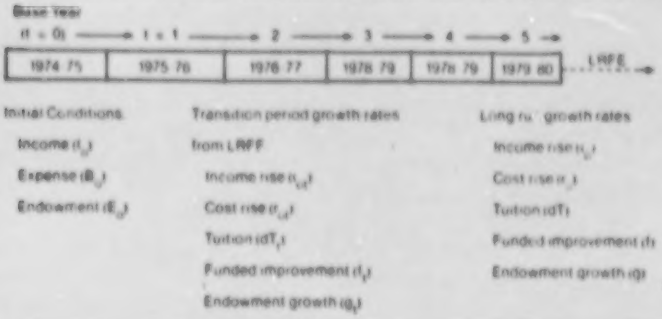
growth were held to something like the rate of family income growth in the economy as a whole (say about 7 to 7½ percent when inflation is 5 percent), then there appeared to be virtually no possibility of obtaining regular consolidations and improvement in the operating budget (that is, f approximately equaled 0). Since some entities included in what we have termed "consolidations and improvements" are really unavoidable extra increases in overhead (two notable examples being maintenance costs on new buildings and costs associated with additional government-mandated "accountability" requirements), an f value of zero would almost surely mean that the direct support of academic programs would have to be whittled down over time. In light of this fact, we have found it difficult to imagine getting by with much less than 1 percent consolidations and improvement per year. But Figure 2 told us that with our other assumptions still intact, this goal would probably require tuition growth at a rate of about four percentage points above inflation. It was questionable whether Stanford could sustain such large tuition increases for long, in spite of the fact that we had always maintained a fully funded financial aid program for students who are unable to pay the full cost of attendance. Thus, we have been seeking to find some other degrees of freedom in the growth-rate balance equations (that is, through examining the various other components of r and i), and then to investigate further tradeoffs in a search for a more desirable solution to the long-run problem. Also, we are investigating ways to reduce f, while continuing to maintain a suitable level of dynamism in academic programs.

A TRANSITION-TO-EQUILIBRIUM MODEL

Although the dynamic budget equilibrium model described above can provide much useful information about an institution's primary long-run financial tradeoffs, it is not able directly to assist in solving a chronically imbalanced budget situation such as the one revealed by Stanford's LRFF in 1974. This type of model was constructed to suggest desirable directions of change over an unspecified period of time. It was not designed, however, to produce a solution in terms of the year-by-year evolution of the budget, beginning at the current year and showing what magnitude of corrective action would lead to a position of LRFE in, say, five years' time. A transition-to-equilibrium model is needed to do this job. Generally, this will take the form of a system of simultaneous equations that can be solved for corrective budget adjustments (expense cuts and income improvements) given current-year budget data and transition period growth rates from the LRFF.

The chief elements of such a model are shown schematically in Figure 3. Initial conditions are specified for the base year (1974-75 in the Stan-

Figure 3. Schematic Description of a Transition-to-Equilibrium Model



ford example) along with projected uncontrolled growth rates from the LRFF. These growth rates are taken to apply during the five-year "transition period." At the end of five years, the budget is required to be in a position of LRFE with respect to *long-run* expected growth rates (these are specified separately from the ones used in the transition period) by fulfilling the following three conditions: (1) the budget is balanced in the fifth year (there is no deficit); (2) the endowment payout rate (p) in that year is such that the growth rate of the endowment remains equal to the growth rate of the budget for the given value of f; and (3) the growth rate of tuition (dT) is calculated so that the growth rate of operating income equals the growth rate of the budget. Although operating deficits are permitted by the model during the transition period, these conditions will prevent them from occurring (at least in an expected value sense) in the period beyond.

Once one has introduced variables for transition period budget adjustments, one can easily write down the accounting equations describing the evolution of budgeted income and expense and endowment market value during the five years. The equations corresponding to the fifth year should incorporate the equilibrium conditions given above. Usually, some degrees of freedom will remain in the model (that is, more dependent variables than constraint equations) unless further restrictions are added. Logically, it can be argued that both the timing and the nature (that is, budget cuts versus income improvements) of budget adjustments should be determined judgmentally in advance of running the model. In this case, one adds constraints apportioning the total budget adjustments over the five years and between expense cuts and income improvements, and solves the system uniquely for these variables. (For further technical details on the model, see Hopkins and Massy, 1977.)

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In the initial runs of the model for Stanford, it was assumed that all budget adjustments would be in the form of expense cuts, these to be distributed 20 percent in the first year, 65 percent in the second, 15 percent in the third, and none in the fourth and fifth. These timing assumptions merely reflected the desire to get the job done as quickly as possible, yet allow enough time for careful decisions about which areas in the university would be affected. Using data from the LRFF in Tables 1 and 2, we obtained the results shown in Table 3. This showed that under the "best-guess" forecast assumptions, budget reductions amounting to some $10.2 million would be needed to achieve equilibrium by 1979-80.

One advantage to having a computerized accounting model is that one can readily calculate the sensitivity of solutions to various uncertain parameters. For example, the total return rate on an endowment invested heavily in common stocks is known to be subject to a large statistical variance. Therefore, one must determine the effect of variations in this parameter on the bottom-line expense cut figures. Figure 4 compares results for Stanford based on the assumptions of a low return (8 percent per year), the best-guess return (10.2 percent per year), and a high return (15 percent per year). The range in total three-year budget cuts is seen to be only from about $8.8 million (high return assumption) to about $10.9 million (low return assumption). This exhibit responded directly to the concern that our planning might be based on too "conservative" assumptions about the potential of the investment markets in 1974. Even if stocks fully recovered from their depressed levels, we would still be faced with the need to cut the budget by close to $10 million. On the basis of these and other sensitivity analyses performed with the transition model, Stanford launched a $10 million "budget equilibrium program" in 1974, whose announced purpose was to "bring long-run financial equilibrium within reach" by the year 1979-80.

CONCLUSIONS

This paper has presented a modeling strategy for long-range budget planning in a private college or university. Its three major components are:

(1) a long-range financial forecast for examining the impact of uncontrolled growth rates on the institution's operating budget over a period of several years;

(2) a dynamic budget equilibrium model for separating long-run growth-rate issues from level issues so as to identify a sustainable budget level and feasible growth rates for those items of income and expense that can be controlled; and

(3) a transition-to-equilibrium model for developing a plan to bring the budget into a position of long-run financial equilibrium over a specified

TABLE 3

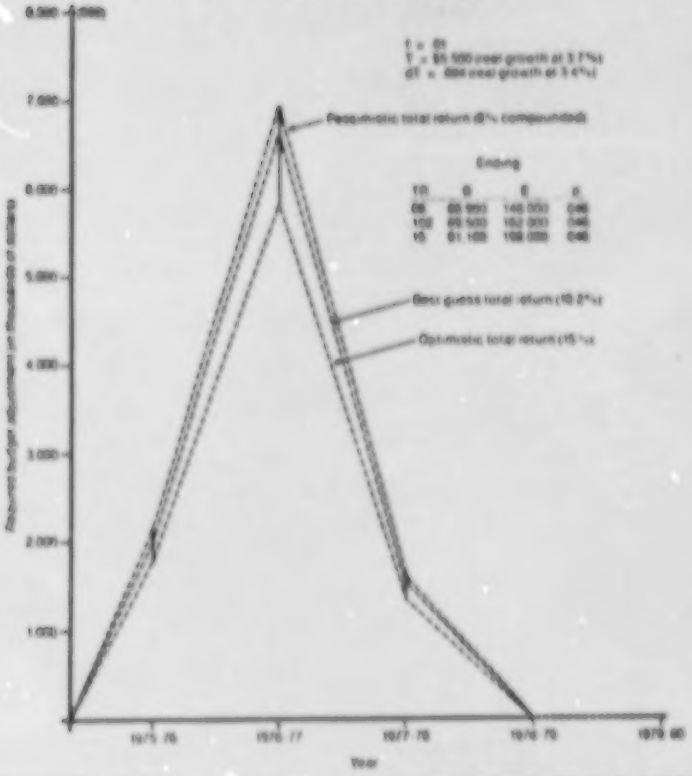
Transition to Equilibrium Without Phase-Out Costs
(Budget figures expressed in thousands)

Parameters: f=.01, Final Tuition T= $5500, dT=.084 in the Long Run

	1975-76	1976-77	1977-78	1978-79	1979-80
Endowment Value (Beg. of Year)	$116,471	$122,907	$134,635	$148,463	$162,233
Endow. Payout Rate	6.8%	6.3%	5.7%	5.1%	4.6%
Tuition Rate	$ 3,800	$ 4,225	$ 4,650	$ 5,075	$ 5,500
Tuition Income	$ 39,710	$ 44,151	$ 48,592	$ 53,034	$ 57,475
Endowment Payout	7,976	7,712	7,677	7,614	7,390
Total Income	$ 68,266	$ 73,134	$ 79,094	$ 84,048	$ 89,519
Maintenance Budget	$ 71,889	$ 76,844	$ 76,726	$ 81,899	$ 88,692
Net New Expenditures	652	705	709	739	827
Budget Reductions	(2,042)	(6,638)	(1,532)	(0)	(0)
Total Base Expenditures	$ 70,499	$ 70,911	$ 75,903	$ 82,658	$ 89,519
Phase-Out Expenditures	0	0	0	0	0
Deficit*	2,233	(2,233)	(3,191)	(1,390)	0

*A negative deficit merely indicates that a portion of endowment payout is being captured for reinvestment so that future earnings will be sufficient to maintain equilibrium beyond 1979-80.

Figure 4. Feasible Budget Reduction Schedules for Different Endowment Returns



period of time.

The LRFF is prepared by a bottom-up process involving the judgments of line managers about detailed income and expense items. This information is consolidated to form the data for the other two models, both of which are formulated in terms of much more aggregate variables. These latter two are used expressly for top-down planning and decision making. Their ultimate purpose is to identify a financial strategy for achieving equilibrium, which may involve a sequence of one-time budget cuts or income improvements or both. Their use provides information necessary at the central administration level for determining the *magnitude* of corrective actions that must be taken, but, of course, the identification of specific programs to be cut must be made by other means.

The emphasis throughout has been on imbedding budget planning in a multiyear context, so that the future impact of current decisions can be gauged, at least broadly, that is, for the institution as a whole. We have found the models to be informative in several ways: they have assisted in the identification of the most critical variables for planning purposes; they have enabled us to quantify the tradeoffs among those critical financial variables; and, finally, they have provided the background against which hard decisions have had to be made. Moreover, and probably at least as important as the benefits listed above, they have formed a basis for discussion and communication on campus that has raised considerably the level of debate about these hard issues. With the models as a common frame of reference, disagreements about the major planning assumptions have been aired quite constructively.

The approach described here seems to have served Stanford well in charting its course of action during difficult times. The object of this paper has been to provide enough detail about the tools we have used so that other institutions that are concerned about their future financial viability might be able to adapt them to fit their own particular needs. Of course, any institution that is still growing, or otherwise expecting to undergo changes over a prolonged period of time, will probably not find the long-run financial equilibrium concept useful to apply. In such cases, however, it can be argued that a LRFF with enough structure to model the financial impact of the changes taking place should be all the more worthwhile. Finally, one should not underestimate the rewards that can come from an institution's taking stock of just what the critical variables are for budget planning purposes and how these might best be fit together in a computer model. The very process of constructing a model often reveals new insights which then can be exploited in simulating the chief implications of various plans for the future.

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3

TRADES: A Model for Interactive Financial Planning

Nathan Dickmeyer, David S. P. Hopkins, William F. Massy

"Can we keep tuition increases down and still give our faculty the pay raises they deserve?" "If utility prices continue to rise can we still allocate a portion of our budget to new programs?" These financial planning questions and others like them have motivated administrators at Stanford University to seek the assistance of a computer model called TRADES to forecast university expenses and income. TRADES is driven by several forecasting sub-models each of which is dependent on the values of a set of Primary Planning Variables (PPVs) controlled by the model user. Because the model readily displays the financial impact of trade-offs between PPVs (e.g., how much must faculty salary increases go down if tuition increases are reduced?), the user is able to assess the effect of these trade-offs and can test tactical decisions more easily. This paper describes the TRADES model and its use at Stanford. "TRADES" is a convenience term for "Trade-offs."

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TRADES AS A FORECAST MODEL

In its most detailed Stanford version, TRADES can display fifty income, expense, and asset categories projected for up to twenty-five years (see Figure One). TRADES also allows the selection of printouts less detailed than the one shown in Figure One.

Submodels. Forecasts of income, expense, and asset items are built from financial submodels which vary in their level of complexity. The simplest of these submodels applies growth rates to project a particular line item such as the one labelled "Equipment" in Figure One. Step functions are also possible with TRADES. At a level of complexity above this, some items are forecast with a growth rate which is derived from other items in the budget. For example, Stanford has targeted certain gift flows at a rate of increase equivalent to the salary and benefit rate of increase. TRADES derives the salary and benefit rate of increase in order to create this gift income forecast. Still other items, such as faculty salaries, library acquisitions, and tuition income, are expressed inside the model as the product of an underlying physical variable and its unit cost or price, each of which may have its own associated growth rate.

More complex submodels are based on careful studies of specific financial sectors which have revealed important interrelationships among the variables. For example, Stanford's recovery of indirect costs allocated to sponsored research has been the subject of such a study. [Massy, W.F., Hopkins, D.S.P., and Carry, J.R., "Indirect Cost Recovery: A Model and a Protocol," Stanford University Academic Planning Office Report No. 76-2 (December 1976)] TRADES forecasts indirect cost recovery as a function of the forecasts of indirect cost pool levels (such as operations and maintenance and indirect departmental administration), cost allocation parameters, and the research fraction of total direct cost.

A second complex submodel is the one used to forecast the undergraduate financial aid budget. This submodel combines predictions of funds from external aid sources, aid endowment performance, size of the student body, and tuition price to come up with projected aid requirements.

A third submodel charts the level of endowments by combining the forecasted effects of gifts, total return from investment, and payouts. Two options exist in TRADES for projecting endowment payout: either one can stipulate a fixed payout rate (percent of beginning market value) in which case surpluses and deficits are calculated, or one can let the model determine what payout is needed to balance the budget in each future year.

Primary Planning Variables. One convenience of TRADES is that administrators may interactively alter variables to create new forecasts and to

Figure 1

EXPENSES

YEAR ENDING	1979,	%	1980,	%	1980,	%	1981,
FACULTY SALARIES	201.0,	1501,	210KB,	1770,	21780,	2021,	21702,
OTH TEACHING	1285,	101,	1388,	110,	1480,	110,	1630,
OTH PERSONNEL	31107,	2070,	33788,	2010,	36010,	1744,	39761,
TAGS	1722,	100,	1820,	11%,	1961,	107,	2070,
SALARY REQS	3284,	201,	3512,	190,	3631,	121,	3702,
TOTAL SALARY	55001,	4101,	60202,	4001,	65101,	5010,	70105,
STAFF BENEFITS	12870,	1400,	13701,	1730,	14380,	2007,	17107,
SALARY AND S.B.	67910,	7071,	73903,	6001,	80401,	7017,	88101,
LIBRARY ACQ.	6152,	601,	6010,	690,	5500,	781,	6251,
U.G. AID	6760,	670,	5181,	621,	5000,	193,	6810,
GRAD AID	2710,	101,	2987,	201,	3169,	252,	3401,
STUD HEALTH	1533,	111,	1668,	111,	1821,	174,	1997,
BLDG. MAIN	1701,	120,	1909,	170,	2109,	210,	2300,
UTILITIES	7010,	877,	8015,	1011,	9020,	900,	10710,
GROUNDS	600,	100,	901,	110,	1102,	100,	1206,
CUSTODIAL	1721,	226,	1957,	210,	2197,	211,	2400,
EQUIPMENT	483,	20,	512,	30,	562,	13,	575,
TRAVEL	877,	80,	958,	80,	1000,	70,	1070,
E.B. AND B.	8130,	960,	8091,	970,	8271,	850,	9005,
OTHER	8951,	190,	9117,	907,	9500,	800,	10101,
CHARGEOUTS	-4555,	-451,	-4000,	-535,	-4510,	-595,	-5180,
TOTAL BUDGET	106251,	9141,	115000,	10514,	125921,	11601,	137120,
REST YEARS P	511,	-101,	700,	201,	610,	97,	807,
TRANS TO OP RES (+)	711,	60,	570,	-176,	170,	-630,	-450,

INCOME

YEAR ENDING	1979,	%	1980,	%	1980,	%	1981,
TUITION/FEES	61800,	5101,	66900,	5062,	72960,	6201,	79150,
PO FROM UNR. POOL	7805,	777,	707),	777,	8610,	800,	9409,
PO FROM SPEC. INV.	911,	61,	992,	65,	1059,	78,	1137,
RET AM AR'LS	17,	191,	200,	0,	210,	00,	201,
TOT. UNR PO	8841,	1010,	9871,	809,	9881,	919,	10000,
PO FROM RES. POOL	5817,	555,	5092,	600,	6501,	666,	7215,
	0,	0,	0,	0,	0,	0,	0,
TOT RES. PO	5817,	555,	5092,	600,	6501,	666,	7215,
UNRES' GIFTS	2117,	170,	2050,	167,	2001,	156,	2750,
OVRD M OVT GNT	670,	10,	200,	10,	290,	10,	100,
TOT UNRES' GIFTS	2787,	169,	2766,	157,	2901,	166,	2867,
RES' GIFTS	1670,	101,	1821,	161,	1006,	201,	2170,
SPEC. FUNDS	811,	70,	901,	70,	963,	91,	1050,
RES FUNDS POOL	5101,	471,	5055,	510,	5771,	561,	6111,
SAI	1120,	61,	1171,	67,	1222,	69,	1276,
SEC LOANS	110,	0,	110,	0,	110,	0,	110,
OTHER	1000,	60,	1000,	60,	1120,	67,	1201,
OTHER INCOME	5610,	100,	5000,	630,	6227,	690,	6001,
RETRO IRU COSTS	2211,	1000,	24062,	2010,	25155,	2705,	29661,
TRF TO PLANT	-1965,	-151,	-2121,	-170,	-2202,	-191,	-2076,
ABF SCHOOLS	619,	0,	619,	0,	619,	0,	619,
INC. IMPROV.	108,	0,	100,	0,	100,	0,	100,
TOTAL INCOME	106711,	9202,	115070,	10130,	120897,	10771,	130071,
TOTAL OPERATING RES.	4469,	511,	2010,	170,	1100,	170,	2077,

Note: The figures in all examples are derived wholly from fictional data.
Note: Schools of Business and Medicine, Hoover Research Institute, and all auxiliary services are excluded.
[An explanation of abbreviations appears on page 69.]

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examine various financial trade-offs. To make variable manipulations easier Stanford has taken a small subset of the approximately 200 working variables and called them Primary Planning Variables. These variables are considered of high importance to the decision maker. These are the variables which a decision maker would be most interested in "playing with." Most of these are true decision variables, such as the number of faculty and the size of the undergraduate student body. Some, however, are often outside the control of administrators but are of such magnitude, impact, and uncertainty (e.g., utility rates) that it is useful to assess their effects at a variety of levels. This kind of sensitivity analysis provides answers to questions such as "What would happen if either our worst or our best utility increase forecasts came true?"

Thus TRADES allows the user to enter new PPV values at any year. These PPVs are of three general types:

- Base values – e.g., numbers of students, numbers of faculty, etc.
- Growth rates – e.g., tuition price increase rate, faculty or staff salary increase rates, etc.
- Coefficients – e.g., the percentage of faculty who are tenured, the percentage of budget dedicated to new, incremental programs, etc.

The Relationship of PPVs and the Submodels. In general, the PPVs drive the submodels. That is, once a variable is declared a decision variable, its level is set (or left at some default value) only by the user. It is not calculated by a forecasting submodel. However, the decision maker is free to decide on the mode preferred for some variables. Switches are used to change a variable from decision mode to submodel mode. For example, a switch can be set so that the user is placed in control of the endowment payout rate. Endowment payout would thus be declared a decision variable. Or the switch can be set to cause a submodel to calculate the payout rate according to a formula. One possible formula calculates the rate such that the budget deficit remains at zero.

Not every variable can be allowed to be a decision variable, however. The cognitive strain on the user would be too great. Many variables are assumed to be set by policy in terms of dollars per a particular PPV level. Thus each PPV change induces a series of marginal cost and income changes. For example, an increase in the number of faculty positions increases fringe benefit costs, the number of academic support staff, and also variable nonsalary costs. Faculty members also participate in indirect departmental administration, a portion of which is recoverable from sponsored research. Thus an increase in faculty positions increases indirect cost recovery income. "Driven" variables like nonsalary costs per faculty FTE are not part of the PPV set but are used to assess the financial impact of decisions on PPV changes. An increase in the decision variable, faculty

FTE, automatically causes nonsalary costs to increase. It should be noted that even these "driven" variables can be moved to the PPV set should the decision maker wish to do sensitivity analyses on them. A decision maker may find it useful to test the effect of a 10 percent increase in variable nonsalary costs per faculty FTE, for example.

TABLE I
Primary Planning Variables

Base Values		
1.	FAC	Full-time equivalent regular faculty members, i.e., professors
2.	UG	Head-count of undergraduate students registered for autumn quarter
3.	GR	Head-count of graduate students registered for autumn quarter
Growth Rates[1]		
4.	DT	Annual real growth in tuition price
5.	DFS	Annual real growth in faculty salaries
6.	DSS	Annual real growth in staff salaries
7.	DUT	Annual real growth in per unit utilities costs
8.	DSBT	Annual real growth in staff benefits costs which vary directly with faculty or staff FTE
Coefficients		
9.	TENR	Ratio of FTE tenured faculty to total FTE regular faculty
10.	STER	Ratio of FTE academic support staff to regular faculty
11.	P	Stipulated endowment payout ratio as a percentage of year beginning market value
12.	F	Budget enrichment factor as a fraction of the preceding year's total budget

[1] Real growth is the percentage increase above inflation.

FINANCIAL TRADE-OFFS

A discussion of trade-offs must begin with an examination of the constraints which force such measures. The most obvious constraint is budget balance: expenses equal revenues. With TRADES, Stanford administrators have also sought to implement some more dynamic constraint concepts [for more details of the equilibrium concept as it applies to universities, see Hopkins, D.S.P., and Massy, W.F., "A Model for Planning the Transition to Equilibrium of a University Budget," *Management Science*, Volume 24, No. 11, (July 1977), pp. 1161-1168; Massy, W.F., "A Dynamic

TABLE 2. Explanation of Obscure Abbreviations

Abbreviation	*Full Listing*				
OTH TEACHING	Other teaching faculty	NEXT YEAR'S F	Budget enrichment dollars. Total amount of incremental new program expense included in next year's budget.	UNREST GIFTS	Unrestricted gifts
OTH PERSONNEL	Other nonfaculty personnel			OVHD N GVT GNT	Overhead recovery on nongovernment grants
TA's	Teaching assistants			REST GIFTS	Restricted gifts
SALARY REQS	Salary requisitions			SPEC. FUNDS	Special funds
SALARY AND S.B.	Salary and staff benefits	TRANS TO OP RES	Transfer to operating reserve, i.e., surplus/deficit	EXP FUNDS POOL	Interest on expendable funds pool
LIBRARY ACQ.	Library acquisitions				
U.G. AID	Operating budget undergraduate financial aid	PO FROM UNR POOL	Payout from unrestricted endowment	SEC LOANS	Interest on security loans
GRAD AID	Operating budget graduate financial aid	PO FROM SPEC. INV.	Payout from specific investments	REIMB IND COSTS	Reimbursed indirect costs
		NET AN RNTLS	Net annual rentals	TRF TO PLANT	Transfer to plant
BLDG MAIN	Building maintenance	TOT UNR PO	Total unrestricted payout	ABF SCHOOLS	Net income from medical/business schools
E.M. AND S.	Expendable materials and supplies	PO FROM RES. POOL	Payout from restricted endowment	INC. IMPROVEMENT	Income improvement

Equilibrium Model of University Budget Planning," *Management Science*, Volume 23, Number 3 (November 1976), pp. 248-256.] One dynamic constraint is that the growth rate of expenses should not exceed the growth rate of income items. This is an important concept since many of the Primary Planning Variables are indeed growth rates. Thus, at Stanford it is specified that in order for a configuration of variables to be acceptable (to borrow from optimization model terminology, this state will be called "feasible" from now on), it must result in budget balance in the first year and in at least one future year as well.

For the sake of efficiency the tendency has been to specify equilibrium for a small number of years. For example, a first-order equilibrium constraint specifies that the budget should be balanced in the base year and one year into the future (or if a surplus occurs in the base year, then there should be at least the same size surplus generated in the next year). Although this does not guarantee a balanced budget ten years hence, it has been found that by controlling the growth rates to achieve first-order equilibrium, enough of a balance has been created to guarantee that future problems will be manageable.

The TRADES model also allows flexible constraint design. Up to fifth-order equilibrium could be specified if so desired. Another interesting constraint is a version of stationary equilibrium which forces a sort of inter-generational equity. That is, the fraction of the budget that is supported by tuition could be restricted to its present level. This would mean that future students would not have a greater burden for financing the university than present students. Another version of stationary equilibrium would freeze the fraction of the budget supported by endowment. Other constraints are possible. One might specify that benefits be allowed to grow to no more than a certain percentage of salaries. Or a limit could be placed on the student/faculty ratio.

Constraints also have a geometric interpretation. In considering all the possible combinations of three PPVs, it should be noted that some of those combinations are feasible with reference to a certain set of constraints. The feasible solutions form a region with the constraints as boundaries and the changing PPV levels as the three dimensions. If one is using sixteen PPVs the same is true, but one must then somehow imagine a sixteen-dimensional space. It is more practical to imagine a two-dimensional slice through the feasible space. This picture would show the feasible trade-offs between a given pair of variables along whatever boundaries (constraints) restrict them.

Option 5 of TRADES allows such a view of two-dimensional slices through feasibility space. Figure Two is a graph of the real growth rate of tuition (DT) against the budget enrichment fraction (F) (the fraction

Figure 2

OPTION? (TYPE 11 TO VIEW THE LIST.)
=>

TRADES

of the previous year's budget used to fund incremental programs and improvements). This graph allows the decision maker to evaluate the possibilities of using one variable to improve the setting of a higher priority variable. The decision maker can note the location of the present configuration on this graph and can see how far it is from boundaries. Note that the slope of the boundary is given in the display. The decision-maker can see that a 1 percent increase in DT would allow a 0.5 percent increase in F. This information facilitates trade-offs. At that rate of exchange, the decision maker may ask, "Would I be willing to raise tuition 1 percent in order to achieve a 0.5 percent increase in the budget enrichment fraction?" The model does not solve the problem for him, but it does allow the user to ask trade-off questions in terms of financially equivalent units for the variables in the trade.

Other ways of examining the feasibility space are provided. One of these is a variable by variable test. By how much must each variable be changed if it alone is used to find the feasible boundary? If the configuration is already feasible, this distance is called the variable's slack. If it is infeasible, it is called the variable's violation.

Option 2 of TRADES lists these variables by variable distances from the feasibility boundary. In Figure Three, the configuration is infeasible because of the high growth of expenses compared to income. A solution to the problem in Figure Three is to increase real growth rate of tuition by .013, eliminating the .013 violation (.023 at the boundary less the .010 in the current configuration). Note that the amount of change for the real growth of tuition would also eliminate the violation for *all* the PPVs since that change would move the configuration as a whole into the feasible region. Table 1 explains the PPV abbreviations.

TRADES can also determine the trade-off values in more than two dimensions. If a set of variables is specified by the user to change in a set ratio (in other words, DT might be set to change upward at half the rate at which F was being changed), the model will show how far the variables can be altered in these ratios before the boundary is reached. It is also possible to set a target for any variable and to examine the trade-offs among the other variables necessary to achieve that value. The trade-offs may be done against any number of the other PPVs to achieve the target.

It is possible to do these trade-offs in any year the user specifies. That is, once the model's base parameters have been well established, it is possible to cycle the model ahead such that the data available to the trade-off routines represents a future state.

Figure 3. Variable by Variable Boundary Test

```
 OPTION? (TYPE 11 TO VIEW THE LIST.)
=>2
 NAME      LIMIT OF DECREASE  CURRENT  LIMIT OF INCREASE
    1 FAC       575.9602        770.0000**************
    2 UG  **************        5450.0000    8868.9453
    3 GR  **************        4400.0000    6723.1953
    4 DT  **************           0.0100       0.0230
    5 DFS         -0.0080           0.0200**************
    6 DSS          0.0020           0.0200**************
    7 DUT         -0.1040           0.0200**************
    8 DSBT        -0.2400           0.0750**************
    9 TENR        -0.1740           0.6000**************
   10 STFR        -0.1240           0.4000**************
   11 P   **************           0.0470**************
   12 F          -0.0015           0.0050**************
 *** INDICATES A VARIABLE THAT HAS REACHED ITS UPPER OR LOWER BOUND.
 *** INDICATES THAT NO LIMIT EXISTS.
 OPTION? (TYPE 11 TO VIEW THE LIST.)
=>
```

IMPACT OF TRADES UPON THE STANFORD ADMINISTRATION

The Search for Decision Variables. One of the most interesting and continually evolving aspects of TRADES has been the selection of PPVs. While the number of faculty is clearly within the administration's control, it is less clear that the growth in cost of faculty salaries is completely within administration control. These costs may indeed be determined by campus policies regarding a level of excellence and thus by market mechanisms where the market is made up of those other universities striving for a similar level of excellence. Why bother making faculty salary growth a decision variable? Why not just build a submodel which could generate the projected future market effects on this variable? The answers to these questions are similar for all situations where we have debated a variable's level of "decisionability."

- Even though a policy may exist with regard to the standard of excellence of the university, the policy cannot be upheld in a vacuum. Under certain conditions, an administrator may wish to deviate from what the market seems to demand (especially over the short run) to meet other demands more threatening to the university.
- In the short run, this rate is absolutely under the administration's control. The setting of this rate historically has been a major budget decision.
- The market mechanisms are so indistinct that the exact setting necessary to achieve a given level of excellence for this variable is unknown. There is sufficient flexibility in any prediction that the administrator will wish to move the rate around anyway.

To summarize, decision PPVs are generally those where (1) the need to use them in trade-offs exists (either due to the amount of leverage on the budget or the uncertainty surrounding their prediction), (2) where the decision makers are able to exercise control, and (3) where the possible prediction submodel produces results sufficiently uncertain that the decision maker will wish to rely on his own judgment much of the time.

An even more interesting example is the rate of increase of fringe benefits cost. Although this problem has not been completely solved, the issues have become clearer. Can these costs be disaggregated into controllable and noncontrollable portions? Is the need to use them in trade-offs great enough to justify calling them decision variables? Is it possible to buck the labor market when it comes to employee benefits?

One of the side benefits of the TRADES model has been the illumination of "decision opportunities." [Cohen, M.D., and March, J.G., *Leadership and Ambiguity*, New York: McGraw-Hill, 1974.] In at least a few cases, the model has caused administrators to examine areas which were previously unexplored.

The Search for Marginal Costs. Part of submodel development has been the attempt to determine the full budgetary changes caused by changes to single PPVs. The first rule we have used is that a change in the level of one PPV should not affect the levels of others. One exception has been that whenever the budget enrichment fraction is changed, there is a change in the number of faculty in the following year. Budget enrichment causes a supplemental increase in the number of faculty in the new programs. We do not want the decision maker to be overridden by the model when he tries to set a decision variable.

A second rule is that the calculation of marginal cost and revenue rates should reflect changes directly attributable to the changes in the relevant PPVs. For example, more students mean more financial aid costs, more infirmary costs, and more costs to the registrar; but care was taken not to include all student services costs. Admissions office costs were felt to be proportional to the number of applicants, not the number of students, for example.

Third, if a cost was found to be related to a change in a PPV, its unit cost per PPV was assessed, based on reasonable amounts of change. That is, no attempt was made to determine the impact of registrar costs of adding one more student. This would probably be zero. The average per-student cost was not used because many of the registrar's costs are fixed, e.g., computer programmers. First, an assessment was made of the reasonable amount of change to the relevant PPV which the administration might wish to examine. Then, for example, it was asked if the student body were to increase by this reasonable change, say 200 students, by what amount would the registrar's costs probably go up?

The Creation of Submodels. As decision makers have come to rely on TRADES more, there has been a growing push to refine the submodels. TRADES has spawned several parallel investigations (and nurtured several others which were already in progress). Can the utilities forecasting be improved? What are the major cost components associated with utilities? Are these components likely to have differing rates of consumption change and differing rates of per-unit cost growth?

Stanford is also studying historical fluctuations in its graduate financial aid budget, the levels of charge-outs, and endowment performance.

TRADES has provided a focus for these research projects. Previous studies have provided a series of interesting facts as to why certain portions of a line item may be increasing. But now TRADES asks for a coherent prediction for the entity or entities represented by the line item.

Intellectual Control. Unfortunately, it is all too easy to let a model like this get out of control. After a while, only a small set of specialists

knows why it does what it does. Stanford administrators have tried to formulate some guidelines to prevent this situation.

- Budget group members (the provost's top budget advisors) are encouraged to have "hands-on" experience with the model. It is important for the decision makers to know how much control they have over the model. It is important that we listen and try to make changes to overcome the shortcomings they notice.
- Should any user question any number which the model produces, it must be explained and derived by hand, no matter how tedious the process. Some results are counter-intuitive (at least temporarily) due to the number of feedback loops. It has been found very helpful to stop any session and show where the questioned numbers were derived. Occasionally, errors have been found.
- Whenever a forecast is run, a listing is made of what was assumed. Occasionally we are dissatisfied with the way some number is modeled. If decision makers are shown the modeling assumptions, there is usually feedback as to how else to proceed.
- Involve the specialists. The indirect cost recovery submodel could not have been built without the aid of those who negotiate the recovery rate. Although views of the process differ somewhat, every session together helped to improve understanding.

Maintaining intellectual control is not easy, given ever-increasing opportunities for enhancement and for extension to cover more budget problems. But, in the long run, intellectual control is the *sine qua non* of validity and credibility. Therefore, Stanford is trying to proceed with caution while broadening participation of the university community. Where necessary, administrators are prepared to eschew expansion into complex areas or even to step back to less sophisticated techniques until a greater understanding can be achieved.

A GENERALIZED VERSION

In conjunction with a pilot implementation of TRADES at several other schools, a version of TRADES called GENTRA (GENeralized TRAdes) has been created, which retains the options of TRADES, but contains a much more basic set of financial routines which is less specific to Stanford than TRADES. Variables like room and board income and state appropriation have been added. An operating manual exists for this program and can be obtained at cost from the Academic Planning Office at Stanford. [Dickmeyer, N. and Hopkins, D.S.P., "GENTRA: *GEN*eralized *TRA*des Model," Academic Planning Office, Stanford University (June 1977).]

CONCLUSIONS

It should be emphasized that many of the basic strategies for financial planning were evident before the creation of TRADES. Earlier work with long-range economic models of the university defined acceptable equilibrium configurations in terms of much more aggregate variables. Work with the TRANS (transition to equilibrium) model provided a means for determining the intermediate steps necessary for going from budget disequilibrium to budget equilibrium. Another phase of Stanford research has been the investigation of methods for the direct assessment and optimization of university decision maker preference functions. [Hopkins, D.S.P., Larreche, J., and Massy, W.F., "Constrained Optimization of a University Administrator's Preference Function," *Management Science* (December 1977)] and [Wehrung, D.A., Hopkins, D.S.P., and Massy, W.F., "Interactive Preference Optimization for University Administrators," *Management Science*, February 1978.] This research strengthened understanding of primary planning variables and the difficulties which decision makers have in being directed toward optimal feasible university financial configurations. Before developing TRADES, therefore, we had a sense of how to do projections, what characterized a feasible configuration and how more preferred configurations could be devised by trading-off variables. Viewed in this light, the real significance of the TRADES model is that by taking care of all the tedious financial calculations, the model frees the user to focus on his or her value preferences for alternative PPV configurations.

4

Management of Endowment Funds at Stanford

Rodney H. Adams

Write a statement of investment goals and objectives. Include and deal explicitly with expected return, risk, payout, debt/equity mix plus diversification, turnover, and the like. Fine, but where do you start? We know enough to understand the importance of these factors, but it is not clear as to how we specify an appropriate payout rate, a desired level of risk, or an acceptable balance between bonds and stocks.

Until very recently, the typical investment policy statement was qualitative in nature, and in the most simple form gave only a general, overall goal such as "seek maximum total return." To the extent statements went further, all too frequently undefined terms were used and often conflicting emphasis was created. There was no way to measure actual results against specific expectations. Even early quantitative approaches unfortunately were deterministic in nature, being more an extrapolation of recent occurrences rather than an appreciation for the uncertainty of future events.

Why should you have an investment policy statement? Well, it's nice to know where you are going. The act of developing and approving a well thought out statement for an endowment fund will bring home to both an institution's administration and its governing board what can be expected from the endowment fund. Those responsible for budgeting will become aware of the probabilistic, or uncertain, nature of future investment re-

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sults. Expectations, described in quantifiable terms, will be affected by an awareness of what is attainable given a stated utility preference (risk exposure). Risk will be defined and understood. An appreciation of the probable outcomes from investing will extend also to understanding the likelihood of being able to maintain a desired level of payout in real terms. The written statement also, quite obviously, serves as a clear directive and communications vehicle of the portfolio manager, typically expressed in terms of limits on investment strategy. Actual results can be compared with stated objectives, the best technique of all to determine performance.

In 1975 Stanford University developed a lengthy statement of investment goals, objectives and policies, the result of a couple of years of effort. The overall, more general goals can be considered typical of what would be desired for any endowment fund. In part these goals are as follows:

1. Provide spendable endowment income which is reasonably stable and predictable from year to year.
2. Follow a spending rule (payout rate) that maintains the purchasing power of endowment income and protects the real value of endowment principal.

The emphasis on real payout is apparent. This is further expanded upon by the objective that the increase in the spending appropriation (payout) over time should equal the average institutional inflation rate, in order to maintain and support budgeted programs.

Our paramount concern is to be able to maintain a stated payout rate in real terms. The endowment equation that describes all the forces that contribute to change includes a total return assumption made up of a real rate of return on investment assets, an expected inflation factor, and a risk/liquidity premia for stocks and bonds. To this, we add a factor for expected gift additions to endowment. The real growth of endowment is reduced by payout distributions. Each year, to achieve our objective, the payout must be increased by the institution's inflation rate.

The increase in payout rate is higher than conventional inflation indexes in that research indicates educational institutions have experienced an extra 1½ to 2% inflation premium. Fortunately, over time, gift additions tend to offset this additional premium. In theory, and if the capital markets were to adequately compensate for inflation in a given year, we could almost eliminate inflation from the equation.

DEFINING THE SPENDING RULE: CRAWLING PEGS

In practice, it is extremely useful to project out payout rates and endowment values in both nominal and real terms. An endowment fund is

similar to a mature pension fund, in that it is in a "distribution" phase rather than "accumulation" phase, and as such, payout rather than cash flow addition is the critical issue. If the goal is to maintain real payout, then payout rates must be projected out into the future to test spending rules. This is a departure from the approach of most endowment simulation programs, where market values only are projected and tested.

According to a recent survey by the National Association of College and University Business Officers (NACUBO), the most common spending rule currently in use is a specified percent amount of a three-year moving average of market values. A 5% rate is most popular at this time. Depending upon the average used, and the lag involved, a 5% average translates over the long-run into a smaller percent amount of beginning current value. These small amounts might well be the difference between building, keeping constant, or consuming the endowment.

The use of moving averages for payout is typically an attempt to provide stability. Maintenance of real purchasing power is rarely, if ever, considered in quantifiable terms other than implicitly in the focus on improving market values. At Stanford University we have chosen to be more explicit in confronting inflation and have developed a payout rule that puts the need to offset inflation in contention with changes of market value. Our payout equation incorporates a "crawling peg" which equals the prior year's payout adjusted for inflation, and in symbols is as follows:

$$P_1 = P_{11}\,(1 + I) + \theta\,[.05\,E_{avg} - P_{11}\,(1 + I)]$$

In words, this year's payout equals last year's, adjusted for inflation plus a weighting factor times 5% of a three-year moving average, less the same crawling peg. Our weighting factor, θ, is set at 0.4. If it were set at 1, then we would have a simple three-year moving average. A theta of zero would result in a payout rate determined solely by our crawling peg. In effect, we assign 40% of the importance to the moving average and 60% to inflation. We determined our specific weighting factor through running simulations of payout versus different θ values. In our tests, a θ of 0.4 dampened down considerably the impact of extraordinary demands on the endowment because of exceptionally high inflation rates. The symbol E_{avg} simply represents a three-year moving average of endowment market values.

Other conditions are also specified for payout determination within the Stanford policy statement. Any income in excess of the amount of appropriation is reinvested for future use (surprisingly, this is a departure from conventional practice). To the extent that current year's earned income is insufficient to meet the budgeted spending rate, reinvested prior year's income may be drawn upon. And, to the extent that current and re-

invested prior years' income is insufficient, capital appreciation of up to 1% of the average market value may be drawn upon to supplement earned income. This allows for some appropriation of gain, but only within strict limits.

The development of a set of specific policy statements is a rather convoluted process. So far, we have outlined an understanding of the overall goals for the endowment fund and a relatively comprehensive set of payout rules. Now, how do we set about to achieve these goals?

The simple answer is to specify a level of risk (or beta) and a stock/bond mix for the endowment. To do this in an informed manner, however, requires dealing with the probabilities of investment outcomes. In turn, this necessitates using simulation techniques. And further, the payout rules must be tested, as it turns out that these do affect the eventual stock/bond mix decisions.

HOW CAN WE FORECAST RETURNS?

When we began developing a detailed policy statement at Stanford, there were few investment simulation programs available. With the aid of a grant from the Lilly Endowment, we were able to commit the resources of our Graduate School of Business, through Professors William Sharpe and Jack McDonald, toward creating a simulation program.

Initial steps taken were the development of distributions for inflation and excess returns to stocks. By examining data for 1925-1973, Sharpe found that the stock excess return distribution had a geometric mean of 6.9% and a variance of 21.5%. This data showed no serial correlation, and one year's value had no predictable effect on the next year's. Thus, our simulator assumes a random walk or efficient market hypothesis in the distribution of the stock returns, and a log normal distribution serves as the base for the simulator's draws for actual events.

Inflation data were serially correlated, as one would expect. Thus, the best estimate of next year's inflation was the previous year's inflation with a slight revision toward the long-term average. The simulator uses a normal distribution for inflation with mean determined from the current yield curve and a standard deviation of 2%.

The means and standard deviations of both stock return and inflation distributions are easily adjustable if other hypothetical cases are to be tested. Since the simulator is a tool to help predict the future, the distributions of excess return and inflation that are used should be based on expectations of what is to come. The point of using a full distribution rather than just a point estimate is that some poor and some good experiences occur. With these results and an appropriate utility curve or risk preference, one that might indicate the institution's conservative or

optimistic preferences, an optimal set of operating parameters can be determined.

THE SIMULATION PROCESS

The actual process the simulation uses is as follows. The simulator determines expected inflation from three variables. The first two, present and long-run inflation, are set at the beginning of the program, and are taken directly from the yield curve for government securities since the rates called for are the risk-free, one-year rate and the infinite maturity rate. The other variable is last year's actual inflation. In year one there is no last year's value, so expected inflation is the value input for present inflation. The computer now determines the expected value for the next year by assuming it will be 6% closer to the long-term value. The computed actual value is this expectation plus a random variable.

The computer uses the expected inflation to generate a one-year T-bill rate with a mean of 1% more than expected inflation and a standard error of .3%. With the new actual inflation and the long-term inflation expectation, the computer creates a new interest rate curve. To do this, the computer assumes a liquidity premium of 1.5% for a bond of infinite maturity. The premium is not a linear function of time; rather, each additional year to maturity adds a smaller and smaller additional liquidity premium. Thus, a ten-year bond includes a premium of .69% while a twenty-year bond includes 1.06%. Now the computer can calculate a new set of forward rates and determine the actual return on bonds of any maturity. The simulator sells these bonds and buys new par bonds to start the next year. This process of moving to par bonds is what occurs in real tax-exempt portfolios, although at a slower rate. If prices go up, managers tend to sell premium bonds to get away from being called. If prices go down, discount bonds are sold to raise current yield.

To simulate stock returns, the computer uses expected inflation as a base. A random log-normal variable with a mean of 6.5% and a standard deviation of 21.5% is added to the expected risk-free return (T-bills). The 6.5% mean for excess stock return over inflation was computed in the same way as the Ibbotson and Sinquefeld study of fifty years of U.S. capital markets. The 1973 estimate of the mean was 6.9%. In 1974 it was 6.1%. After 1975 it was 6.5%. While this variation is disturbing, other less statistical bank and advisory services estimates of stock excess return range from 4.5% to 14%. Thus, a range of 6.1-6.9% over several very volatile years is not comparatively large.

The standard deviation of the stock excess returns has recently been shown by Rosenberg and others to move in a somewhat mean reverting manner. While the simulator does not actually use this relationship, it is

programmed to allow for the standard deviation of excess stock returns to vary.

This completes the output to the file on total return for stocks, bonds, and T-bills. The yield for stocks and bonds is also out on the file, bonds yield their coupon (bonds are assumed to be Government, no risk of default), and stocks yield dividends according to a statistical best fit relationship obtained from twenty years of data on Stanford's stock portfolio. This part of the model is a naive estimate that predicts this year's percentage yield adjusted for the market return from last year to be the same as last year's. A reasonable manager ought to be able to do better than that prediction by avoiding stocks where dividend cuts are likely. The Stanford yield relationship does have a long-run upward tendency, so it is not totally naive (neutral).

The file is now complete. There are two programs to the Stanford simulator. The first one simulates the capital markets using the distributions previously explained. This program outputs onto a file the returns year-by-year for the following variables: Inflation, T-bill rate (1 year), stock total return, bond total return, stock yield, and bond yield. The program performs up to 2,000 annual simulations. Thus, 100 simulations of twenty years or 200 simulations of ten years are possible. We could do more simulations than this, being only limited by time and equipment constraints.

An example of the output derived from this first program is given in Exhibit 1-A, wherein we plot the basic market variables for 1977 (this was generated as part of our planning process in September, 1976). At that time, we obtained a quote of 6.30% for a one-year Treasury bill, and this is shown as the one line of output, labeled "short interest rates" for year 1. If you deduct a real rate approximating 1%, you obtain the mean inflation rate shown at the top of the exhibit. While this may be the expected inflation rate, the distribution shown describes possible other rates that could occur for the coming year.

In like manner, the Exhibit 1-B provides a distribution of possible stock and bond total return outcomes. Note that the stock returns are log-normal and skewed towards positive returns. This is the expected result. Bond returns are a more normal distribution.

With this file, a second program takes a set of investment rules and produces the simulated experiences. Investment rules can include any small or large details about the portfolio that are programmable. Generally, the following are included: time horizon (years), stock/bond mix, payout rule, bond maturity mixture, stock yield differential over S & P 500, and starting values. Minor details such as residual variance (specific risk) of the portfolio or any cash reserve pools have been successfully

[illegible] SIMULATOR PROJECTIONS OF BASIC BALANCE SHEET VARIABLES FOR 1977

INFLATION

DIST. FOR FISCAL YEAR ENDING 1977 MEAN = 5.40 STD. DEV.= 1.40

LOWER BOUND		UPPER BOUND	# OF TIMES			
-3.00	<	-2.50	1	:*		
-2.50	<	-2.00	0	:		
-2.00	<	-1.50	0	:		
-1.50	<	-1.00	0	:		
-1.00	<	-0.50	0	:		
-0.50	<	0.00	3	:***		
0.00	<	0.50	0	:		
0.50	<	1.00	1	:*		
1.00	=	1.50	5	:*****	< 5%	1.50
1.50	=	2.00	6	:******		
2.00	=	2.50	8	:********	<10%	2.25
2.50	=	3.00	10	:**********		
3.00	=	3.50	10	:**********		
3.50	=	4.00	10	:**********	<25%	3.80
4.00	=	4.50	13	:*************		
4.50	=	5.00	17	:*****************		
5.00	=	5.50	13	:*************		
5.50	=	6.00	16	:****************	<50%	5.61
6.00	=	6.50	20	:********************		
6.50	=	7.00	21	:*********************	<75%	6.95
7.00	=	7.50	15	:***************		
7.50	=	8.00	9	:*********		
8.00	=	8.50	5	:*****	<90%	8.40
8.50	=	9.00	3	:***		
9.00	=	9.50	7	:*******		
9.50	=	10.00	3	:***		

RISK-FREE SHORT-TERM INTEREST RATE

DIST. FOR FISCAL YEAR ENDING 1977 MEAN = 6.00 STD. DEV.= 0.00

LOWER BOUND		UPPER BOUND	# OF TIMES	
6.00	=	6.50	200	:**********

DIST. FOR FISCAL YEAR ENDING 1978 MEAN = 5.43 STD. DEV.= 1.16

LOWER BOUND		UPPER BOUND	# OF TIMES			
3.50	=	4.00	5	:*****		
4.00	=	4.50	7	:*******	< 5%	4.35
4.50	=	5.00	10	:**********	<10%	4.90
5.00	=	5.50	21	:**********		
5.50	=	6.00	32	:**********	<25%	5.62
6.00	=	6.50	16	:**********	<50%	6.45
6.50	=	7.00	28	:**********		
7.00	=	7.50	86	:**********	<75%	7.00
7.50	=	8.00	11	:**********	<90%	8.00
8.00	=	8.50	14	:**********		
8.50	=	10.00	6	:******		

Exhibit 14

SBI SIMULATOR PROJECTIONS OF BASIC MARKET VARIABLES FOR 1977

STOCK TOTAL RETURN

DIST. FOR FISCAL YEAR ENDING 1977 MEAN = 13.50 STD. DEV.= 24.00

LOWER BOUND		UPPER BOUND	# OF TIMES			
-35.00	-	-30.00	1	:*		
-30.00	-	-25.00	2	:**		
-25.00	-	-20.00	8	:********	< 5%	-20.62
-20.00	-	-15.00	6	:******		
-15.00	-	-10.00	13	:*************	<10%	-13.05
-10.00	-	-5.00	18	:******************		
-5.00	-	0.00	20	:********************	<25%	-6.50
0.00	-	5.00	14	:**************		
5.00	-	10.00	21	:*********************	<50%	0.29
10.00	-	15.00	12	:************		
15.00	-	20.00	13	:*************		
20.00	-	25.00	15	:***************		
25.00	-	30.00	12	:************	<75%	27.02
30.00	-	35.00	10	:**********		
35.00	-	40.00	5	:*****		
40.00	-	45.00	3	:***		
45.00	-	50.00	9	:*********	<90%	47.79
50.00	-	55.00	5	:*****		
55.00	-	60.00	2	:**		
60.00	-	90.00	9	:*********		

RISK-FREE LONG-TERM BOND TOTAL RETURN

DIST. FOR FISCAL YEAR ENDING 1977 MEAN = 7.65 STD. DEV.= 6.85

LOWER BOUND		UPPER BOUND	# OF TIMES			
-10.00	-	-5.00	2	:**		
-5.00	-	0.00	22	:**********************	< 5%	-3.10
0.00	-	5.00	36	:************************************	<25%	2.61
5.00	-	10.00	39	:***************************************	<50%	7.00
10.00	-	15.00	25	:*************************	<75%	11.93
15.00	-	20.00	16	:****************	<90%	15.96
20.00	-	25.00	7	:*******		

evaluated also. Output of this program is most often a graphical display of the full distribution of ending values. An abbreviated form gives only the ending value at various percentiles (5, 10, 25, 50, 75, 90) of the distribution. Output can be for any of the variables. These include unit share market value, pool market value, payout, yield, inflation, real return, real share value, and real payout.

A LOOK INTO THE FUTURE

Sample outputs, for different debt/equity mixes, are shown in Exhibit II-A & B. This is the complete, graphical display showing the distribution of 200 simulations. In this instance we are looking at a forecast of payout rates five years into the future, for 1981. This is a test of both our spending rule and different portfolio compositions. The results are given in dollars per share, since our endowment pool is maintained as a unit share value basis akin to an open end mutual fund. As the percent in equities is increased, the mean value result also increases. At the same time, the range of outcomes broadens, with some additional negative values and many more positive values occurring.

In this program we also test our spending rule. The information shown below each distribution provides us with readings of the number of outcomes that breach our rules. First, we wish to know how often we have insufficient yield or current earned income. Next, for these instances when we have a shortfall, we wish to know how often we have insufficient prior years' income built up in a cash reserve. Finally, if we consume all current and past years' income, we wish to know the prospects of being without sufficient capital gains. In the 70% debt example, we only violate the insufficient yield test with nine occurrences, or 4½% of the time. Recognize, however, that the most likely payout is low. At the 15% debt level, we have insufficient yield one quarter of the time, insufficient past years' income reserves about 10% of the time, and insufficient gain about 6% of the time. What is our utility function; can we live with these shortfalls in payout?

THE ULTIMATE DECISIONS

Given a desired payout goal over time, we can now develop a means to determine an acceptable range of bond/stock mix. Setting our variables, we can generate a whole series of outputs for different mixes. An example of our short form of output, giving just ending values at various percentiles, is shown as Exhibit III. Drawing upon this output, we can plot a graph of likely results for different portfolios. We have found that plotting possible outcomes as a probability of making a target goal is a helpful means to cause trustees to focus on their risk preference.

The possible range of outcomes for different portfolios, in achieving our target for share values out five years in the future, is shown in Exhibit IV. Using this date, it is easy to observe that bond percentages above 60% to 70% offer no help, but rather detract from achieving long-term goals. In a similar manner, but to a lesser degree, as the equity percentage increases, the probability of being under target first declines dramatically,

PAYOUT DISTRIBUTIONS 1981
5% 3-yr. Average, 0 = .5

Debt/Equity = .70/.30

DIST. FOR FISCAL YEAR ENDING 1981 MEAN = 0.882 STD. DEV.= 0.050

LOWER BOUND	UPPER BOUND	# OF TIMES			
0.65 -	0.69	7	;*******		
0.69 -	0.72	13	;*************	5%	0.651
0.72 -	0.75	23	;***********************	10%	0.701
0.75 -	0.78	28	;****************************	25%	0.750
0.78 -	0.81	34	;**********************************	50%	0.800
0.81 -	0.84	35	;***********************************		
0.84 -	0.87	26	;**************************	75%	0.851
0.87 -	0.90	17	;*****************	90%	0.886
0.90 -	0.93	4	;****		
0.93 -	0.96	9	;*********		
0.96 -	1.02	5	;*****		

MAX % INCR = 0 MAX % DECR = 0
INSUFF YLD = 0 INSUFF C.R.= 0
INSUFF C.G.= 0

Debt/Equity = .40/.60

DIST. FOR FISCAL YEAR ENDING 1981 MEAN = 0.838 STD. DEV.= 0.141

LOWER BOUND	UPPER BOUND	# OF TIMES			
0.48 -	0.51	1	;*		
0.51 -	0.54	0	;		
0.54 -	0.57	0	;		
0.57 -	0.60	2	;**		
0.60 -	0.63	2	;**		
0.63 -	0.66	4	;****		
0.66 -	0.69	11	;***********	5%	0.661
0.69 -	0.72	11	;***********		
0.72 -	0.75	16	;****************		
0.75 -	0.78	22	;**********************	25%	0.751
0.78 -	0.81	15	;***************		
0.81 -	0.84	15	;***************		
0.84 -	0.87	15	;***************	50%	0.841
0.87 -	0.90	14	;**************		
0.90 -	0.93	15	;***************		
0.93 -	0.96	11	;***********	75%	0.932
0.96 -	0.99	15	;***************		
0.99 -	1.02	9	;*********		
1.02 -	1.05	9	;*********	90%	1.010
1.05 -	1.08	1	;*		
1.08 -	1.11	3	;***		
1.11 -	1.14	4	;****		
1.14 -	1.66	5	;*****		

MAX % INCR = 15 MAX % DECR = 1
INSUFF YLD = 29 INSUFF C.R.= 7
INSUFF C.G.= 1

Exhibit II-A

Debt/Equity = 10/ 90

```
DIST. FOR FISCAL YEAR ENDING 1991        MEAN = 0.053    STD. DEV.= 0.223

     LOWER      UPPER    # OF
     BOUND      BOUND    TIMES
     -----      -----    -----
     0.38 <     0.33       1  |*                                          |
     0.33 <     0.31       0  |                                           |
     0.31 <     0.39       0  |                                           |
     0.39 <     0.42       0  |                                           |
     0.42 <     0.45       1  |*                                          |
     0.45 <     0.48       1  |*                                          |
     0.48 <     0.51       1  |*                                          |
     0.51 <     0.54       2  |**                                         |
     0.54 <     0.57       0  |                                           |
     0.57 <     0.60       3  |***                                        |
     0.60 <     0.63      10  |**********                                 | 5%  0.601
     0.63 <     0.66       5  |*****                                      |10%  0.636
     0.66 <     0.69       9  |*********                                  |
     0.69 <     0.72       9  |*********                                  |
     0.72 <     0.75      15  |***************                            |25%  0.735
     0.75 <     0.78       9  |*********                                  |
     0.78 <     0.81      13  |*************                              |
     0.81 <     0.84      11  |***********                                |
     0.84 <     0.87       8  |********                                   |
     0.87 <     0.90       5  |*****                                      |40%  0.862
     0.90 <     0.93      14  |**************                             |
     0.93 <     0.96      10  |**********                                 |
     0.96 <     0.99      11  |***********                                |
     0.99 <     1.02       6  |******                                     |
     1.02 <     1.05       6  |******                                     |75%  1.050
     1.05 <     1.08      11  |***********                                |
     1.08 <     1.11      11  |***********                                |
     1.11 <     1.14       5  |*****                                      |
     1.14 <     1.17       5  |*****                                      |90%  1.159
     1.17 <     1.20       3  |***                                        |
     1.20 <     1.23       2  |**                                         |
     1.23 <     1.26       2  |**                                         |
     1.26 <     1.29       7  |*******                                    |
     1.29 <     1.32       3  |***                                        |
     1.32 <     1.35       1  |*                                          |
     1.35 <     1.89       6  |******                                     |
MAX % INCR = 61    MAX % DECR = 5
INBUFF FLO = 50    INBUFF C.O.= 21
INBUFF C.O.= 12
```

Exhibit IV-B

then reverses and slowly increases. Depending on an institution's own risk preference, a range of asset mixes (or one point) can be chosen to minimize the chances of being under target.

Much to our surprise, we found that similar computations plotting a range of outcomes for payout differed from share value targets. Upon reflection, we concluded that this is what should be expected, given distinct spending rules that included moving averages, weighting factors, and the like. Since the goal of our endowment is to achieve and maintain payout targets, we rely on graphs like that shown in Exhibit V to help us set bond/stock ranges. At Stanford, we have specified a range for stocks of not less than 50% nor more than 70% of our portfolio. Further, we have

```
                    ASSUMED MODEL B

DROP IN EQUITY,BONDS,STOCKS,REAL ESTATE ?   0.05    0.25    0.40    0.10
BETA FOR STANDARD PORTFOLIO ? 1
DESIRED YIELD DIFFERENTIAL ON STOCKS ? .5
THETA ? .4
FIVE YEARS VALUE'S OF ENDOWMENT ? 275000 250000 190000 220000 240000
MENIU OUTPUT: 1=REAL/BAL, 2=PAYOUT/BAL, 3=REAL RETURN, 4=CASH ECO/BAL,
5=PAYOUT/C.D., 6=DEFLATR, 7=REAL/BAL (COST 0), 8=PAYOUT/BAL (COST .01 )
```

```
DIST. FOR FISCAL YEAR ENDING 1977        MEAN =13,736   STD. DEV. = 2,360

    5%       10%       25%       50%       75%       90%       95%
 -------   -------   -------   -------   -------   -------   -------
 10,661    11,000    11,861    13,393    15,255    16,143    20,600
```

```
DIST. FOR FISCAL YEAR ENDING 1978        MEAN =16,961   STD. DEV. = 3,621

    5%       10%       25%       50%       75%       90%       95%
 -------   -------   -------   -------   -------   -------   -------
 11,750    13,500    14,375    16,667    19,071    21,900    25,000
```

```
DIST. FOR FISCAL YEAR ENDING 1979        MEAN =16,646   STD. DEV. = 5,045

    5%       10%       25%       50%       75%       90%       95%
 -------   -------   -------   -------   -------   -------   -------
 11,625    13,214    14,857    17,611    21,056    21,000    25,000
```

```
DIST. FOR FISCAL YEAR ENDING 1980        MEAN =16,062   STD. DEV. = 6,262

    5%       10%       25%       50%       75%       90%       95%
 -------   -------   -------   -------   -------   -------   -------
 11,600    13,500    15,111    18,792    22,800    24,333    26,000
```

```
DIST. FOR FISCAL YEAR ENDING 1981        MEAN =21,651   STD. DEV. = 8,226

    5%       10%       25%       50%       75%       90%       95%
 -------   -------   -------   -------   -------   -------   -------
 11,167    13,500    16,667    20,143    25,617    33,000    39,500
```

Exhibit III

set a portfolio beta of no more than 0.7 as our desired risk level. Simulation tests indicate we can achieve our goals within these limits.

After we first went through this process, we sat back and tried to describe to ourselves what were the most significant insights we had learned. In part, we concluded the following:

1. Achieving payout targets is the goal for endowment.
2. The expected real return for an endowment is a function of the bond/stock mix.
3. The expected real growth for endowment is a function of the spending rule (payout amount).

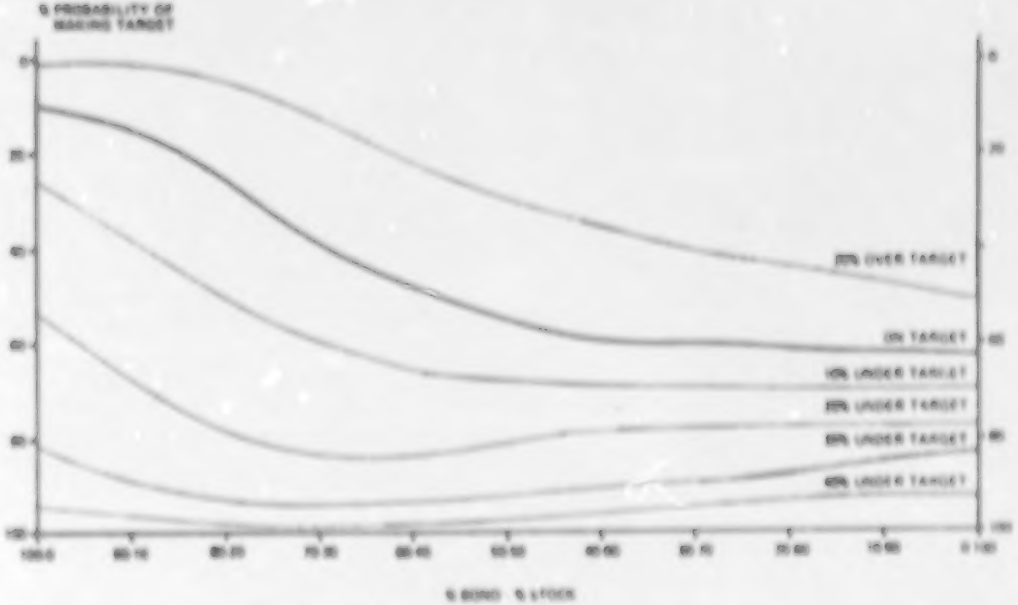
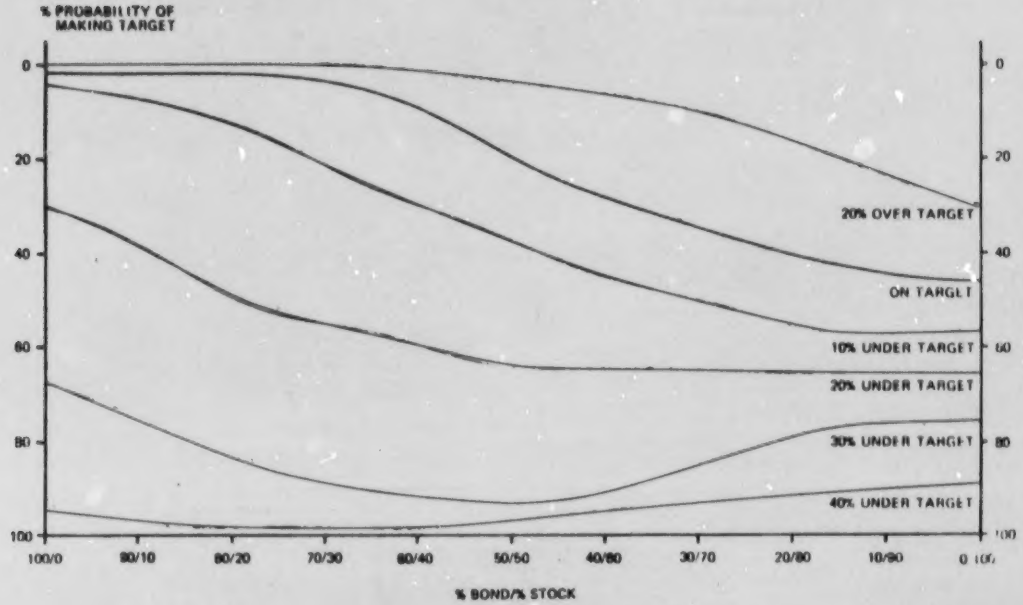

% PROBABILITY OF MAKING TARGET
20% UNDER TARGET
10% UNDER TARGET
20% UNDER TARGET
30% UNDER TARGET
40% UNDER TARGET

EXHIBIT V
ENDOWMENT PAYOUT PER SHARE
PROBABILITY OF MAKING TARGET
IN 1981



II. APPLICATIONS OF FINANCIAL PLANNING MODELS

5

Models as Planning Tools: The Harvard Experiment

Sally H. Zeckhauser

INTRODUCTION

The seventies have not brought prosperity to colleges and universities, and Harvard is no exception. While Harvard has not suffered as much as some universities have, it has shared many of the problems that have plagued its colleagues. After a decade of rapid growth in which the total University budget increased at an average annual compounded rate of ten percent, Harvard's growth rate dropped to little over 5 percent during the five years from 1969 to 1974. When account is taken of the much higher rates of inflation over the later period, the decline in the rate of real growth is dramatic.

Some Background

By 1974 increasingly squeezed budgets and persistent queries by the Governing Boards had made it clear that the task of allocating the university's resources required careful planning. As a result certain steps were taken to ensure that the long-term financial implication of policies were considered. The University Budget Office required departments to submit a planning-year budget as well as a budget for the upcoming fiscal year. Construction proposals had to include estimates of the project's impact

on continuing costs. A special committee chaired by President Bok reported in very general terms on the long-run growth rates to be anticipated in the various income and expense categories. An "Income/Expense Policy Statement" based on the committee's findings was later issued in the University's *Financial Report*. Conspicuously absent from this repertoire were planning models.

The general attitude toward planning models at that time was one of robust skepticism. While models were not new, they appeared to university decision-makers to have serious drawbacks. Some were so rigid they were impossible to adapt in a meaningful way to any other organization; others were so complex they were incomprehensible to the executives that were supposed to use them; and still others were so standardized that they could not capture the unique quality of a complex research institution like Harvard. While there were some real problems with the use of planning models, the university's indifference reflected preconceived notions of the value of this technical approach. Few if any of the top executive decision-makers in the university had either the time, the training, or the inclination to become embroiled in model-building efforts whose payoff seemed more academic than practical.

Aware of both the objective and subjective problems, Joe Wyatt, then Director of the University's Financial Systems, learned of the set of aggregated planning models developed at Stanford, models which served an important role in decision-making at an institution not unlike Harvard. He decided to see whether this approach could prove as useful a tool in planning and policy-making at Harvard as it had at Stanford. In 1974 Harvard began to experiment in the application of computer-based models to simulate the long-term growth pattern of certain operating budgets. This report describes that experiment – its results and implications.

The Financial Environment

To be useful to decision-makers at Harvard, any planning model had to reflect the unique characteristics of the university. In reality, Harvard is a federation of ten semi-autonomous schools, each with its own educational mission and academic priorities. Decisions about which faculty to hire and promote and which students to admit are made locally. This philosophy known as ETOB, "Every Tub on Its Own Bottom," is also firmly established in the university's financial structure.

For decision-making purposes, there is no university-wide budget. Each school sets, within broad limits, its own tuition rates, salary schedules, and aid policies. Primary responsibility for its annual budget rests locally as well. Should a deficit be incurred, a school must deplete its own endowment or borrow funds from the university at the going rate; sur-

pluses in one school are not transferred to aid others in financial trouble. Each schools "owns" its own endowment, but most funds are managed in a common pool, with a centrally determined investment and payout policy. Certain services, such as accounting, operations and maintenance, and police protection, are also centrally provided and are paid for on a fee-for-service basis or by assessments levied on each department. In addition, the ETOB framework is complicated by a myriad of agreements and "treaties" that spell out a variety of financial obligations and entitlements. Any useful planning model must be able to maintain the separate identities of these individual "tubs," while capturing their complex interdependencies.

The modeling experiment described here expanded over four years into four quite different areas of the university. Given the blend of priorities and personalities, it provided a rich experience by which to assess the usefulness of modeling as a planning approach.

The Approach

Specifically, the Harvard effort focused on four areas:

- *The Faculty of Arts and Sciences* (FAS), which includes all undergraduate instruction as well as virtually all non-professional graduate education
- *The Graduate School of Education*, which provides masters and doctoral level training in education
- *Buildings and Grounds* (B&G), an administrative department which operates and maintains the university's physical plant
- *The Harvard College Library*, which houses the central library collections of the Faculty of Arts and Sciences.

In each of these applications, Harvard maintained the methodology of the basic forecasting models developed at Stanford. The model structure was simple. Budgets were broken down into a small number of income and expense categories as appropriate; values and relationships were established for the individual categories and rates of change tied to the general economy (inflation and personal income) were selected. Direct payments and expenditures for federally sponsored grants and contracts were excluded. The overall objective was to provide insight into the long-run stability of the current budget configuration.

Then sensitivity analyses were made to gauge the financial impact of changes in the values of various parameters so that decision-makers might assess the feasibility of alternative long-run strategies. Beyond this standard methodological framework, however, each application varied due to the needs and questions that seemed most important at the time, the way in which each organization operated, and the personalities involved and

their priorities. In effect, the basic methodology had to be remolded in each case to reflect the unique perspective of each group and the decision-makers involved.

For example, while FAS and the School of Education are both academic schools, they faced different dilemmas. FAS, a highly complex faculty involved in a myriad of financial interrrelationships with other university departments, was faced with an unrestricted deficit of over 1 million dollars in 1974. While short-run cuts could bring the budget into precarious balance, the FAS model was designed to highlight the long-run implications of short-term strategies. In the School of Education, on the other hand, financial problems were less crucial than a potential change in its fundamental mission. The School's relatively simple and small core budget was finally in balance after several difficult years of dwindling federal funding. However, a proposal was being seriously considered to reduce the size of the school, focusing more exclusively on research and producing only doctorates.

The scope of the B&G model resembled that of FAS in the complexity of its internal interrelationships and sources of funds. The central concern here, however, was the growing cost burden B&G operations were likely to place on the rest of the university. Again, in the case of the Library, the focus was the external cost burden generated. Since FAS is obliged to cover the unrestricted operating deficit of the Library, the size of this obligation was of primary concern.

On one level, each application of the model methodology has responded to the unique needs of a particular area. Yet a look at this sequence of model efforts over the four-year period shows a logical progression, in part generated by the model work itself, in part aided by organizational and institutional changes unrelated to the model efforts per se.

The balance of this report describes the model-building efforts in these four areas of the University. For each case, a brief overview depicts the financial and institutional environment in which the particular model was developed. The evolution of the model is then discussed; its structure and results, steps in its development and its role in decision-making. Finally, each case ends with some thoughts on the model's impact. With these case histories as background, the report concludes with some general hypotheses drawn from the variegated Harvard experience.

FACULTY OF ARTS AND SCIENCES

The Model Environment

FAS is at the heart, financially and philosophically, of Harvard University. Embracing all undergraduate instruction and virtually all non-pro-

fessional graduate programs, it has by far the largest budget of any school in the University, with actual expenses in fiscal 1974 of about $80 million. By 1974, there was growing concern over the increasing FAS unrestricted deficit, which had reached an all-time high of $1.3 million and showed few signed of abating.

In response, a task force including decision-makers from the school and central administration was established to examine the situation and potential remedies. Among the key participants were the University's Financial Vice-President, Hale Champion, and the Dean of the Faculty of Arts and Sciences, Henry Rosovsky. Champion, a professional administrator, had virtually no training in quantitative modeling techniques and even less natural affinity for them. A canny manager, he was open-minded and a master of using information to orchestrate action on university problems. Rosovsky, an economic historian by trade, was a new dean who assigned priority to balancing the budget. A good working relationship and mutual respect had developed between the two. Both had budget office personnel working directly for them, but in both cases the emphasis was clearly on making next year's budget work to present to the Corporation.[1]

The work of modeling began outside the budgetary bureaucracy as a summer research effort that might provide useful input to task force discussion. Since it was clear from the start that winning political acceptance would be almost as great a task as the technical work, an incremental, low-key strategy was deliberately adopted. Developed with little fanfare and at low cost, the model application had little to lose but much to gain. If the approach provided useful to FAS, it would earn considerable credibility; if the summer project bogged down, top administrators would have lost no time or effort in a futile experiment.

Structure of the Model

Harvard's Faculty of Arts and Sciences was in many ways analogous to Stanford. The two institutions were quite similar in dollar terms, educational mission and the type of faculty employed. Both were in a steady-state situation. However, here the similarity stopped. The host of complex relationships between FAS and various other University departments made it impossible to model the faculty's finances realistically without broadening the scope of the original Stanford model into ten interactive pieces.

For example, although FAS has only limited direct financial transactions with Houses and Dormitories and with the Undergraduate Dining Halls, these departments are important because of interdependencies between decisions about tuition increases and the increases in room and board rates needed to meet expenses. Thus submodels for these departments were built to generate inputs to the main model for calculating

tuition income. In addition, by treaty, FAS is obligated to fund the deficits of the Harvard College Library and the Department of Athletics. Separate submodels for the Library and Athletics were developed to calculate the projected required subventions.

Moreover, the distinction between restricted and unrestricted funds is central to any understanding of FAS financial problems. Although the overall 1973-74 budget was in surplus, problems existed because the surpluses in restricted funds could not be used to cover the unrestricted deficit which amounted to about $1.3 million. Because restricted money cannot generally substitute for unrestricted funds, FAS monies in the main model and submodels were disaggregated into two budgets: restricted and unrestricted.

As the submodels flowed into the simple aggregated simulation model, total income and expenses could be projected for FAS and a cumulative deficit/surplus over the projection period could be calculated. Here, too, the FAS model was different from its Stanford counterpart. The measure it used to display comparative results was the present value of the cumulative surplus/deficit, a contrast to Stanford's focus on the endowment payout rate. With the payout rate at Harvard outside the control of local administrators, this variable was simply not as relevant a measure. Figure 1 displays the seven income categories used in the aggregated FAS model as well as the ten expense components based on the final budget figures for fiscal 1974.

The results of the base run showed unrestricted deficits of more than $1.0 million persisting over the ten-year projection period. Income grew slightly faster than expenses, but the initial deficit was too large to be overcome in ten years.

The growth rate of tuition proved to be the parameter to which the results of the model were most sensitive. The base run tied student receipts (tuition, room, and board) to the growth rate of personal income. Sensitivity analyses showed that decreasing the growth rate of student fees increased deficits significantly, even though student aid expenses also grew less rapidly. Increasing tuition at only the rate of inflation, a policy that would keep the price of higher education constant relative to other goods and services, more than tripled the cumulative unrestricted deficit.

After student receipts, variations in the growth rates of wages and salaries produced the greatest effects in the model's projections. If academic salaries were assumed to rise somewhat more slowly than the national average for all workers, the projected unrestricted deficit was reduced or eliminated. Conversely, higher-than-average increases for wage employees seriously deepen financial problems. The general conclusion suggested by these results was that FAS would continue to face serious

Figure 1: Budget Components in the FAS Model

	Base Budget Components*			
	Unrestricted (including all student aid)		Restricted (excluding all student aid)	
	$1000	Percent	$1000	Percent
Total Income	38,675	100.0	13,948	100.0
Tuition and fees	23,293	60.2	0	0.0
Endowment	5,693	14.7	7,609	54.6
Gifts for Current Use	4,460	11.5	3,114	22.3
Indirect Recovery	2,406	6.2	0	0.0
Other Departments	598	1.5	1,238	8.9
Interest on Department Balance	5	0.0	191	1.4
Miscellaneous	2,221	5.7	1,796	12.9
Total Expenses	39,974	100.0	12,363	100.0
Salaries	10,951	27.4	6,179	50.0
Wages	3,975	9.9	1,628	13.2
Other				
Wage and Salary	502	1.3	468	3.8
Non wage	4,080	10.2	2,426	19.6
Operations and Maintenance	4,211	10.5	1,048	8.5
Other Departments	1,464	3.7	615	5.0
University Assessment	1,089	2.7	0	0.0
Student Aid	8,631	21.6	0	0.0
Library Subvention	3,078	7.7	0	0.0
Athletic Subvention	1,994	5.0	0	0.0
Surplus (deficit)	(1,299)	——	1,585	——

*Most budget amounts are based on Fiscal 1974 actual income and expenses.

but manageable financial problems over the next decade. If expenditures could be reduced, the budget could be kept in equilibrium through a steady-state, no-growth policy.[2]

Interaction with Administrators

The institutional reception of the model was not as straightforward as the preceding discussion may have suggested. The most critical ingredients in the acceptance of the model were its flexibility and simplicity. This coupled with the unobtrusive approach to the use of the model gave it a measured perspective in the planning discussions. The facility with which changes, expansion, and deletions could be made allowed numerous iterations by which the model was refined to reflect the FAS world as the executive decision-makers perceived it.

The preliminary draft report circulated to the task force invited feedback. Though generally of little interest, the concept and its potential did catch the eye of the two key players: Champion and Rosovsky. More out

of curiosity than conviction, Champion drew together Rosovsky and the modeling staff to probe the potential of the exercise. Through this and subsequent meetings, the structural relationships within FAS became more accurately defined; submodels were created and monies disaggregated. While linking growth rates to general economic growth rates seemed at first an arbitrary decision, historical data were gathered that showed the ties to personal income and inflation did in fact have some basis in reality.

Through these iterations the model began to achieve a shape that was consistent with the perceptions of the people who managed and controlled the budget. For example, in the original version of the FAS model as in the Stanford model, the payout rate on endowment was fixed. Champion objected, noting that the university's policy was not to provide a fixed percentage of endowment but to guarantee departments a fixed rate of growth in their endowment income. Although this change made absolutely no difference in the numbers generated by the base case, it did prove a symbolic gesture, enhancing the credibility of the model in Champion's eyes. And the model's flexibility allowed for changes to be made quickly. For people who had little time to pore over technical details, the model's accessibility proved a strong selling point. Its inner workings were comprehensible to those with virtually no background in modeling. No leap of faith was required. The structure was readily understood, results could be easily explained, and traced through the model. Moreover, because sensitivity runs could be easily generated, hypothetical scenarios could be considered without a great deal of manual number-pushing.

After the model was refined to the dimensions determined by Champion and Rosovsky, it provided a basis for comparison in the next three years. During this time it was updated annually after the budget figures became available and as the actual results for the year became known.

Impact on Management

One of the principal values of the FAS model was as an aid to communications. If the model were to reflect accurately the complicated interdependencies of the FAS budget, the structural relationships had to be clearly articulated. For example, the necessity of defining a method for calculating student receipts focused attention on the way FAS administrators saw the links between tuition, room and board. It became clear that FAS, the Dean in particular, viewed these elements as a package; that is, the pace at which tuition could be raised without exceeding families' ability to pay depended upon how rapidly room and board charges were rising.

The model also helped in focusing FAS priorities. First it delineated in stark unarguable terms the variables that could be controlled. For

example, the endowment payout rate is one of the few financial variables set centrally and uniformly for all schools, hence not a decision variable for FAS administrators. However, academic salaries and student receipts are policy variables under the direct management of FAS executives. Second, the model helped to rank the relative importance of issues. The University assessment[3] had been a matter of some controversy. However the assessment, important as it is, consumes only 3% of the faculty's expense budget; the model suggested administrative time and attention would be more fruitfully spent on relatively more significant issues. Finally, the model suggested priority issues for the future belt-tightening. Long on the back burner, the library was shown to be an increasingly serious problem. In fact, the model demonstrated that a continued laissez-faire approach to library management could destroy any delicate budget equilibrium FAS hoped to achieve.

While the model ranked and revealed priorities, its real management value did not come from the results themselves. Given the uncertainty implicit in any planning effort and the broad simple overview provided by this projection model, the numbers were merely suggestive, rather than definitive. As a result, the model was of little interest to internal budget officers, whose top priorities lay with next year's income and expense figures. Instead, its value was tactical, allowing those making general policy decisions to test and understand the implications of broad strategy decisions. The ability to test the relative sensitivities quickly and easily proved more informative than the numerical results generated in any given year.

Efforts to make the model more sophisticated (i.e., provide TRADES capabilities) elicited little interest. Since few FAS administrators were at ease with computer-based models, they were unlikely to be willing to sit at a terminal to consider a range of trade-off possibilities within feasible boundaries — the principal advantage offered by the TRADES methodology. Moreover, to understand TRADES fully would require a greater investment of time and effort than any administrator was willing to make.[4]

In sum, the real benefits of the FAS model came from the process of defining and shaping a concept easily comprehended by non-quantitative decision-makers with a structure that reflected the budgetary world as they saw it. As such, it provided an invaluable framework for the discussion and formulation of future policies.

THE SCHOOL OF EDUCATION

The Model Environment

By 1975 the financial situation in the Harvard Graduate School of Education had finally begun to stabilize. A $200,000 deficit in 1973 had been almost erased two years later, as the school struggled to cope with the withdrawal of federal funds which at one time had made up almost 50% of its income. However, problems still remained. The academic program was in the midst of an identity crisis: 22 doctoral programs had been merged into 5; attrition was high, applications dropping, and the quality of the students seemed to be declining. These factors suggested a re-examination of the fundamental mission of the school, particularly since 50% of the faculty positions were due to change within the coming three years.

In light of this situation, President Bok requested that a committee be set up to consider options for the school's future. As the committee met, three proposals were put forth: 1) to retain the status quo, keeping the school at 550 students of which 450 were masters candidates, 100 doctoral; 2) to enlarge the school along the lines of other professional schools, aiming primarily to make students effective practitioners of the art of education, offering large courses emphasizing general principles; and 3) to cut the size of the school to 200 doctoral students, transforming it into a specialized research unit. The Dean, Paul Ylvisaker, and the President requested that a modeling effort be integrated into any consideration of the three options so that the financial ramifications of each could be included in the committee's discussions.

Structure of the Model

Once again, a simple simulation model was used, similar to the FAS concept but smaller and simpler. The focus of the work was the fiscal 1976 core budget, totaling about $3.5 million. Because the school had virtually no restricted funds, the model was limited to unrestricted monies. Moreover, the school was a virtually self-contained unit with no complicated budgetary relationships with outside departments or faculties. Gutman Library, for example, was an integral part of the operating budget. As shown in Figure 2, the model included seven expense and seven income components.

It was necessary that the model reflect certain idiosyncracies in the school's budgeting procedures. Predetermined, fixed relationships, directly or indirectly tied to student enrollment, were used to determine the dollar level of a number of budget components. For example, tuition income was calculated on the basis of an average tuition rate and the num-

Figure 2: Budget Components in the School of Education Model

	Base Budget Components*	
	$1000	Percent
INCOME		
Tuition	1975	58.9
Fees	24	.7
Current Gifts	60	1.8
Indirect Recovery	398	11.0
Other Departmental Transfers	176	5.3
Miscellaneous	135	4.0
Endowment	585	17.4
Total Income	3353	100.0
EXPENSE		
Salaries	1309	38.4
Wages	437	12.8
Non-Wage Purchases	252	7.4
Operations and Maintenance	535	15.7
University Assessment	149	4.4
Financial Aid	406	11.9
General and Office	322	9.4
Total Expense	3410	100.0
SURPLUS (DEFICIT)	(57)	---

*Base budget amounts are derived from the income and expense estimates for Fiscal 1976.

ber of full-time-equivalent students enrolled. The school also used a student/faculty ratio, and a faculty/support staff ratio in combination with average wage and salary rates to determine aggregate salary and wage costs. As a result, the model had to incorporate not only financial variables, but physical counts as well. Simple formulae which calculated the dollars from physical variables were also integrated into the model. Once these relationships were explicitly specified in the base case, projections over the next ten-year period could be made. Sensitivity analyses varied not only the growth rates of each income and expense component, but also the physical counts and the predetermined relationships.

The ultimate focus of the modeling effort was a comparison of the financial implications over time of a shift to enrollment of only 200 doctoral students. Because a smaller operation would require the modification of a number of assumptions, two base budgets were constructed. In this way both the short- and long-term financial impact of the two pro-

grams could be considered. Figure 3 provides a brief comparison of the assumptions underlying the base budgets.

The results of the model indicated that the 200-student option was an expensive one, largely due to the shift in relative importance of the sources of income. Specifically, tuition revenue became considerably less important in the 200 model, representing only about one-third of all HGSE income, down almost 25 percentage points from the 550 model. The school's dependence on endowment income, generated both as income from capital and through transfers from other departments, increased substantially. Not surprisingly, the role of indirect monies recovered from grants and contracts was greater in the 200 model, since research activity

Figure 3: Comparative Overview of the Assumptions Underlying the Base Budgets

	550 Model	200 Model
Number of Full-time Equivalent Students	550	200
Tuition Rate per Student	$3,590	Same
Student: Faculty Ratio	14.5:1	10:1
(number of Faculty)	(38)	(20)
Average Salaries:		
faculty	$25,000	$29,500
administration	21,800	Same
faculty support	9,600	Same
administrative support	10,000	Same
Non-wage purchase allowance per faculty member	2,500	Same
Financial aid per student	$ 738	$ 1,650
Library (Non-Building) Expenses	390,000	25% reduction
Operations and Maintenance	535,000	See note 1
University Assessment	3.7%of total exp.	Same
endowment income	$585,000	Same
indirect recovery[2]	275,000	Same
transfers from other departments	397,000	Same
gifts, current	60,000	50,000

1. Gutman's building costs, as reflected in the O+M category, do not change since the space reductions assumed possible occur outside the library. Excluding Gutman O+M, the relevant building costs are reduced 19% for the 200 model; including Gutman, HCSE O+M is cut only by 11% overall.

2. This figure represents the current level of recovery on faculty research. Since research activity would be substantial in the 200 model, we assume that the recovery income should not decrease.

would be relatively substantial. However, indirect cost recovery as a source of income was still insignificant compared with endowment and tuition. In addition the smaller model, at least with the base-case assumptions, was simply not able to use its physical space as cost-effectively as the larger model.

As a result, deficits generated by the 200 model are substantial even in year 1. Moreover, the projections indicated that the income problems would become more severe in the future, given the assigned growth rates of endowment and tuition. Because the 550 model is more dependent on tuition (which grows at 6.0%) and the 200 model on endowment (which increases at 4%), the gap between the growth rates in income grows progressively greater over time.

The sensitivity analyses suggested that minor refinements would not be sufficient to make the 200 model financially feasible. Only major adjustments to aid and building expenses could offset the growing income shortfall.[5]

Interaction With Administrators

The legacy of the FAS work, although useful in structuring the technical side of the model, had an adverse effect on institutional involvement in the Graduate School of Education modeling effort. Instead of thinking about the fundamental assumptions upon which the model was based, the executives at the School of Education, who had little or no experience with quantitative management tools, tended to accept the FAS view of the dynamics of the academic world with little in-depth consideration of their own. Although minor revisions were suggested, they preferred to rely on FAS judgements and perceptions as to relationships and values. (The administrators at the School of Education wanted the growth in student aid, for example, to be the same as in the FAS work, even though its constituency was markedly different.) As a result, the Dean and his staff were only minimally involved at one brief staff meeting. With no iterations, the model reflected little of the unique characteristics of the client. Without the process of research, refinement and adjustment, the model was constructed and completed in three person-months.

Impact on Management

To a certain extent, the approach of the school's administrators was predictable and rational. The Dean, who felt he had guided the institution through the stormy late sixties to steady ground, was reluctant to make any fundamental changes. He was wary of any more fiscal uncertainty and believed the faculty was tired of disruption. While convinced that the status quo was in the best interest of the school, he needed a more objec-

tive justification for pursuing this option than his own intuitive feel for the situation. The model filled this need; it made his case with a dispassionate objectivity that was persuasive to the President's committee, restless faculty, an inquisitive President and his pressing Visiting Committee. Using model output, he was able to prove his point to the committee without being accused of gathering biased data as part of a Machiavellian strategy to out-maneuver his opponents. While the model did suggest certain policy priorities, such as a review of the critical role of aid at the school, the Dean proved less responsive than had FAS decision-makers to this sort of suggestion. The model had served a different purpose; it had legitimized his case.

HARVARD COLLEGE LIBRARY[6]

The Model Environment

The impetus for developing the third financial model came in large part from the data generated by the FAS work. From 1970 to 1976, actual Harvard College Library (HCL) expenditures had grown almost 8% per annum, more than twice as fast as FAS expenditures overall. Moreover, the revised 1976 budget estimates indicated that while unrestricted expenses for the entire Faculty of Arts & Sciences had been held to a 3% increase in the past year, those for the Harvard College Library had jumped almost 9%.

This situation might have been less worrisome if the library's own income had kept pace with increasing costs. However, most of the burden fell on the Faculty of Arts and Sciences budget. As indicated previously, FAS supports the unrestricted library deficit through an annual subvention of funds in order to balance the HCL budget. The size of this subvention had more than doubled since the start of the decade, and was almost $4.0 million in 1977, a 9% increase over the previous year.

A principal cause of this serious financial situation was the labor-intensive nature of the library activities. In recent years, almost 60% of HCL actual expenditures had gone to salaries and wages, 90% of which were paid by unrestricted monies. Moreover, from 1974 to 1976, these costs had grown more than 10% per annum. Although some of this rise was due to salary increases to meet national norms, much stemmed from the increased complexity and volume of operations. The university has opened several new libraries (Cabot and Pusey), and introduced new subject areas in which to collect, catalogue and maintain materials (Afro-American Literature, Oral Literature, Near Eastern Languages and Literature).

In contrast to the dramatic increase in personnel expenditures, outlays for acquisitions had grown only 2% per annum during the same period. In

other words, the portion of the HCL budget devoted to acquisitions had lost ground relative to other expenses during a period when the number and price of publications was increasing significantly. Clearly, a continuation of this trend would have serious implications for the library's collection.

The university responded in several ways to this alarming situation. The state of technology in the library was reviewed; an outside consultant was hired to examine library costs and set up a new control system. Committees were set up to examine: 1) the scope and nature of the Library's problems; 2) the governance of the University's libraries; and 3) the HCL finances. There was a growing awareness that the problems of the libraries could not be solved by a few years of tight budgets or quick-fix remedies, but rather required long-term planning and management on a variety of dimensions.

This level of concern, combined with an interest to experiment with one of Stanford's more sophisticated models, suggested the Harvard College Library as an appropriate subject for a model exercise. As with the FAS model, the application was undertaken outside the client environment as a low-profile research effort, eventually to serve as input to the appropriate committees' deliberations.

Structure of the Model

The preliminary work on the Harvard College Library model adopted Stanford's GENTRA[7] methodology. While a part of this approach was not new – the School of Education model had used physical as well as financial planning variables – the delineation of fixed-versus-variable costs and the consideration of tradeoffs within feasible boundaries were clearly more sophisticated concepts than had been applied before. Since the level and nature of acquisitions activity are important determinants of operating costs and subject to policy control, it was decided that serials and monographs would represent the key physical variables and the relevant costs associated with them would be allocated appropriately. Moreover, while the critical fiscal measure had been the budget surplus or deficit in the two previous models, the library model focused on the size and growth rate of FAS support necessary to maintain budgetary balance.

As indicated in Figure 4, the Harvard College Library's budget was separated into six income categories and eight expense categories. Much effort was devoted to generating appropriate assumptions with regard to the variable costs associated with acquisitions, specifically the purchase cost per volume, the salary processing costs per volume (including selection, ordering, receipt and cataloguing of materials), and other processing costs per volume (including postage, binding and computer-processing).

Figure 4: Budget Components in the Harvard College Library Model

	Base Budget Components*	
	$1000	Percent
INCOME		
Departmental Income	359	4.0
Expendable Gifts	61	.7
FAS Support	4502	50.0
University Support	1223	13.6
Other Operating Income	511	3.7
Endowment	2335	26.0
Total Income	8991	100.0
EXPENSES		
Student Salaries	188	2.1
Staff Salaries	4393	48.9
Staff Benefits	686	7.6
Other Expenses	921	10.2
Departmental Transfers	201	2.2
Utilities	376	4.2
Acquisitions	1758	19.6
B&G Expenses	468	5.2
Total Expenses	8991	100.0

*Base budget amounts are derived from the income and expense figures budget for Fiscal 1978.

These per-volume estimates were applied to the assumed number of volumes acquired per year to calculate the amount of "variable" (i.e. acquisition-related) costs. All other costs were by definition "fixed" (i.e. unrelated to acquisitions). With the costs defined and growth rates applied, budgetary projections could be made.

The first run of the model projected only three years forward. Even with conservative expense growth assumptions (no growth in the number of full-time-equivalent professional staff, 2% real growth in salaries and other labor-intensive costs, and no growth in the number of mongraph and serial volumes acquired annually), the FAS subvention had to grow at 10% per annum to balance the budget, implying that the dollar amount of FAS support would double every seven years.

Sensitivity analyses explored the effect of alternate assumptions on budgetary balance. Not surprisingly, given that well over half the HCL budget is labor, the growth in salaries for both professional librarians and

support staff is an important determinant of budgetary balance. As for acquisitions, the model showed that a sustained decline over time in the number of volumes acquired had a greater fiscal impact than a single (but larger) drop in the first year followed by no change thereafter. Since a greater share of the acquisitions budget is allocated to monograph (and other non-serial) materials than to serials, the budget balance was more sensitive to the rate of growth in monograph acquisitions than to the rate of serial acquisitions growth.[8]

Interaction with Administrators

To date, this model work has been isolated from the flurry of management activities concentrated on the Library. Data-gathering has necessitated some contact with Library staff, but key decision-makers have not been directly involved with the work. Three factors seemed to recommend this mode of operation.

First, the library's problems are heavily imbued with institutional politics, raising fundamental questions about the relationship of FAS to the central administration and their role in cost-sharing as well as the role of FAS administration vis-a-vis the library bureaucracy. It seemed wise to keep the model aloof from the politics.

Second, it is not yet entirely clear who will play the key decision-making roles in the library's future. Specifically, in view of the imminent retirement of the University Librarian, a presidential committee has been reviewing the whole question of library governance including who the key decision-makers would be and how they might implement policy.[9] Once these decision-makers have been identified, the presentation of the model, its structure and results can be better tuned to their style of planning and management.

Finally, as suggested by the results described above, the advantages of the more sophisticated approach over the simple projection model remain unclear. In fact, a more complex model without an improvement in the quality of information provided may only confirm the traditional suspicions that models tend to be technical toys rather than productive planning tools. Again, this judgement would depend on the audience.

Impact on Management

Since no feedback has yet been elicited, the impact of this model effort on management decisions in and for the library remains unknown. As the results became refined and the data more provocative, the decision-makers will be asked to consider the model as yet another perspective in examining the library's problems.

BUILDINGS AND GROUNDS

The Model Environment

The fourth, and currently most active, financial modeling effort is directed at the University's Department of Buildings and Grounds (B&G). B&G's responsibilities include custodial service, maintenance, groundskeeping, and the distribution within the university of steam, electricity, and other utilities. With 1977-78 expenditures of $35 million, its budget is among the largest in the university, exceeding those of all but two of Harvard's ten faculties. In keeping with the university's decentralized "ETOB" financial structure, B&G operates as a separate cost center, covering its costs with charges levied on other university departments for services rendered.

Several factors prompted the decision to model B&G's budget. First, the level and rate of growth of its charges are matters of continuing concern, frequently dismay, across the whole University. Second, earlier work with the FAS model suggested that the financial health of other university departments is indeed sensitive to the growth rate of B&G expenditures. Finally, the Vice President for Administration, Joe Wyatt, whose responsibilities include B&G, wanted a long-range, top-down, aggregate financial model to complement other more detailed and operationally oriented studies he had initiated to aid short-term planning and to increase the department's efficiency. Thus, in contrast to the efforts described earlier, the impetus for developing the B&G model came directly from the senior manager with line responsibility for the department concerned.

Structure of the Model

The basic structure of the B&G model is similar to that of the FAS model described earlier, with several important exceptions. As with FAS, the model has five major subunits: 1) Central B&G Administration, 2) Custodial Services, 3) Operations, 4) Central Services, and 5) Utilities. This division corresponds to the current B&G organization chart and to the format used for financial reporting within the department. With the exception of "B&G Administration," each of the five units is headed by a Manager who reports to the Director of B&G, who in turn reports to the university's Vice President for Administration. In addition to projecting the budget of each subunit separately, the model calculates the totals for B&G as a whole.

Within each B&G subunit, expenses are divided into various categories for projection. These categories are listed in Figure 5. Because of differences in benefit rates, four categories are needed to capture salaries and wages. Figure 5 also shows that about 41% of B&G's budget is for em-

ployee compensation; 35% for steam, electricity, and other utilities; and 14% for outside contractors supervised by B&G. All the expense categories, except benefits (which are calculated from the wage and salary categories), are projected using simple growth equations. Each expense category is further divided into direct and indirect costs; direct costs are billed directly to the University departments supplied with specific goods and services; indirect costs are overhead items (such as benefits and administration) whose costs are recovered through a surcharge imposed on direct charges.

Figure 5: Expense Budget Components in the B&G Model

	Budgeted 1977-78	Percent of Total
1. Salaries for supervisory and clerical personnel	2,403	7.0%
2. Wages for craftsmen, laborers, etc. paid weekly	8,152	23.6
3. Wages for casual employees and overtime	280	0.8
4. Wages for students	427	1.2
5. Benefits	2,934	8.5
6. Equipment and supplies	1,934	5.6
7. Miscellaneous, wage-tied	860	2.5
8. Miscellaneous, inflation-tied	706	2.0
9. Contracts	4,821	14.0
10. Miscellaneous utilities (oil, gas, etc.)	1,885	5.5
11. Steam	5,369	15.5
12. Electricity	4,764	13.8
TOTAL EXPENSES	34,537	100.0

Once the model has projected all expenditures for a given year, it calculates the interdepartmental transfers made among the five B&G subunits. The major transfers are to B&G Administration from the other four subunits and from Utilities to Operations for maintenance and repair work done on the utilities' distribution system. In practice, these allocations are determined in a bewildering number of ways, based in some cases on specific services rendered, in other cases on relative budget sizes, and in still other instances on a variety of other formulae. Incorporating these formulae in the model in any detail would have complicated the model tremendously without having any impact on projections for B&G as a whole (since all allocations net to zero at that level of aggregation). Instead, the model calculates allocations based on budget proportions specified by the user.

Since B&G's income consists almost exclusively of charges collected from other university departments, and since these charges are generally constrained to balance expenditures, it would make little sense to project income independently of expenses, and then calculate the resulting surplus or deficit, as was done for FAS. Instead, after the model has projected the expenses and made the required B&G allocations, it calculates the net income required to balance each subunit's budget. Because direct and indirect costs are maintained separately, the model is also able to calculate the surcharge rate required to cover indirect costs.[10] Although the model can generate a variety of different data, the primary summary measures to be used in comparing sensitivity analyses are the growth rate in income required, the surcharge rate, and the present value of income required.[11]

Interaction with Administrators

Development of the B&G model has proceeded under the general supervision of the Vice President for Administration. Administrators within B&G itself have been consulted frequently on specific issues in an effort to make the model conform to actual conditions, and also to obtain their views on what features are desirable. A presentation of the model and some preliminary results were also made to the Director of B&G and other departmental administrators. Their reaction was one of mild interest, and it seems likely that even this interest is influenced more by the attitude of their boss than by their own instincts. In fact, they were clearly skeptical of the direct usefulness of a model that focused on long-range issues, rather than shorter-term operational problems. Thus it may be that the model will receive its greatest use outside of B&G itself, as a policy-making tool for the Vice President for Administration and other top university officials.

Impact on Management

The B&G model is not yet completed, although the interactive computer program has been written and debugged and preliminary runs have been made. In addition to plans for a general sensitivity analysis, a number of specific applications are under consideration. For example, energy costs are a troubling burden for all universities, but particularly for residential colleges located in the Northeast. Thus the model included special features designed to make it easy for the user to examine the impact of energy conservation programs on costs. Another issue of concern to B&G administrators is the appropriate mix of outside contractors and B&G employees for handling various kinds of maintenance and repair work. In the Boston area, a variety of competitive service companies provide alternates to an in-house staff for maintenance and repair in numerous functional areas

such as carpenters, custodians, security guards, and painters. The model should prove helpful in analyzing both of these issues and others.

CONCLUSIONS

Each of the four model efforts at Harvard reflects the idiosyncratic nature of the particular organization. Yet some general conclusions have emerged. Although some converts have been made, the models never met immediate, enthusiastic acceptance.With few exceptions, Harvard decision-makers cannot be persuaded before the fact that long-range computer-based planning models offer real benefits. Each individual case must prove itself useful, whether to legitimize a desired outcome as in the case of the School of Education, or to clarify relationships previously poorly understood as in the case of FAS and B&G, or to restructure priorities as in the case of FAS and potentially the Harvard College Library. Given the pressures on decision-makers' time, this skepticism is not entire unreasonable.

The requirement for immediate utility suggests two key elements in the successful use of models. First, decision-makers must be involved in the design process. It is important to have the executives who formulate policy invest something of themselves in a formal effort they can understand and help to shape. The importance of the second factor, timing, is to encourage this participation. Executive involvement in the process is vital but must be carefully orchestrated. For if decision-makers are involved too early, a planning model can be dismissed as irrelevant and never given a chance to prove its utility. On the other hand, if decision-makers are kept in the dark until the completion of the planning work, the model is unlikely to reflect their needs and concerns accurately. Only by drawing decision-makers into the modeling effort as it evolves can clients and modelers alike derive most benefit from this planning tool.

Footnotes

1. The Corporation comprised of the President and six Fellows is the University's primary governing board. Among its fiduciary responsibilities is final approval each year of all the annual budgets.
2. In essence, the FAS projection model was built from scratch within the methodological framework provided by Massy's work at Stanford. A. L. Nichols was its adept architect, writing the program, gathering the input data, and generating the results.
3. The University assessment is the monies levied on all departments to cover the costs of certain central administrative services such as accounting and personnel.
4. There were other problems with TRADES as well. The model was simply too Stanford-specific to mold effectively to FAS' accounting and organizational structure. Hopefully, the more generalized structure of the EDUCOM model will speak to these difficulties.

5. Data collection and computer work were provided by Ross Roadman and Vincent Polley.
6. Harvard College Library includes FAS' central collections, i.e., Widener, Cabot, Fine Arts, Hilles, Houghton, Lamont, Litteuer, Yenching and Pusey.
7. GENTRA – Stanford's more generalized TRADES model – enables users to test trade-off options within feasible boundaries. Other features include the differentiation of fixed and variable costs and the use of physical variables.
8. Preliminary data collection and computer work on the HCL model has been undertaken by Greg Mills.
9. Essentially the presidential mandate to the committee was to consider how the university's libraries might best be structured to serve scholarly research and instructional goals, and to anticipate new challenges as they arise.
10. As with the allocations, this procedure is a simplification of actual practice. In fact, different surcharge rates apply to different goods and services within each department. The model will be modified to permit the user to specify certain specialized surcharge rates, with the model calculating a general rate for the residual.
11. A. L. Nichols has done the preliminary work on this model.

6

Transition to Financial Equilibrium at Oberlin College

James L. Powell

INTRODUCTION

Oberlin College is the smallest institution included in the Lilly-EDUCOM study. Yet its financial situation is similar to that of Stanford University, for endowment income makes up a significant portion of Oberlin's total revenue. It may be of interest to the reader to assess how well the theory of financial equilibrium developed by Massy and Hopkins can be applied to a well-endowed, but relatively small, liberal arts college. The evidence to date indicates that it applies very well indeed. This account of Oberlin's experience with financial modeling deals more with the evolution of the concepts and their infusion into the governance structure of the college than with the details of the model employed.

OBERLIN AND ITS RECENT FINANCIAL HISTORY

Oberlin is an independent, selective, residential liberal arts college of 2700 students with one major difference from other such colleges; within the institution a Conservatory of Music, enrolling 500 of those students, coexists with a College of Arts and Sciences. Oberlin's Educational and General budget is divided into the standard categories. In 1977-78 it totalled $18,000,000. The endowment on June 30, 1978 stood at

$80,000,000. Tuition and fees made up 83 percent of total income, endowment 26 percent, gifts 9 percent, and other income 2 percent.

During the late 1960's Oberlin's budget was usually balanced, and a modest deficit in one year seemed as likely as not to be offset by a small surplus the next. In the early 70's the situation deteriorated, as it did for almost all institutions, and increasingly large deficits occurred. By 1973-74 the Board of Trustees had become sufficiently alarmed to place ceilings on the Educational and General budget for each of the next five years. The ceilings allowed for some growth in expenditures, but still required cuts of over one million dollars in the College's budget base, analogous to the Budget Adjustment Program at Stanford. By 1976-77 these reductions, together with a significant increase in gifts, had produced a balanced budget. Even members of the Administration rather familiar with the budget breathed a sigh of relief, assuming that the worst was surely over.

This mood lasted until the 1977-78 budget was projected – it showed a $250,000 deficit. It thus became clear that balancing one year's budget had cured the symptoms, but not the cause, of Oberlin's financial ailment. Officers had brought the levels of expense and revenue together for one year, but had not balanced their growth rates.

This realization caused us to examine the rate of growth of various components of the budget, and the factors that determine them. We saw that as long as inflation remained in the 5-7 percent range and the college continued its recent practice of spending all endowment earnings, equivalent to a payout of about 6 percent, total revenue would fall behind expenses each year, and cuts would be required in order to balance the budget.

For the November 1976 meeting of the Board of Trustees, officers prepared a large bar graph, reproduced here as Figure 1, which showed the 1976-77 balanced budget with its income sources and the projections for the next decade. The actual chart was in color, and showed the projected deficits as a red upper section of the bars. Each year the red area increased as endowment income failed to keep up. This chart made a striking impression on the trustees. In December it was presented to the general faculty, with equal impact. In both cases, I was once again struck by the degree to which a simple graph can convey important information more effectively than a table. At the time this chart was presented officers had no solution to offer. However, board members generously agreed to offset half of the anticipated deficit from their own sources while the administration set about finding the other half, and a permanent solution.

FINANCIAL EQUILIBRIUM MODELING

Members of the administration understood that lagging endowment

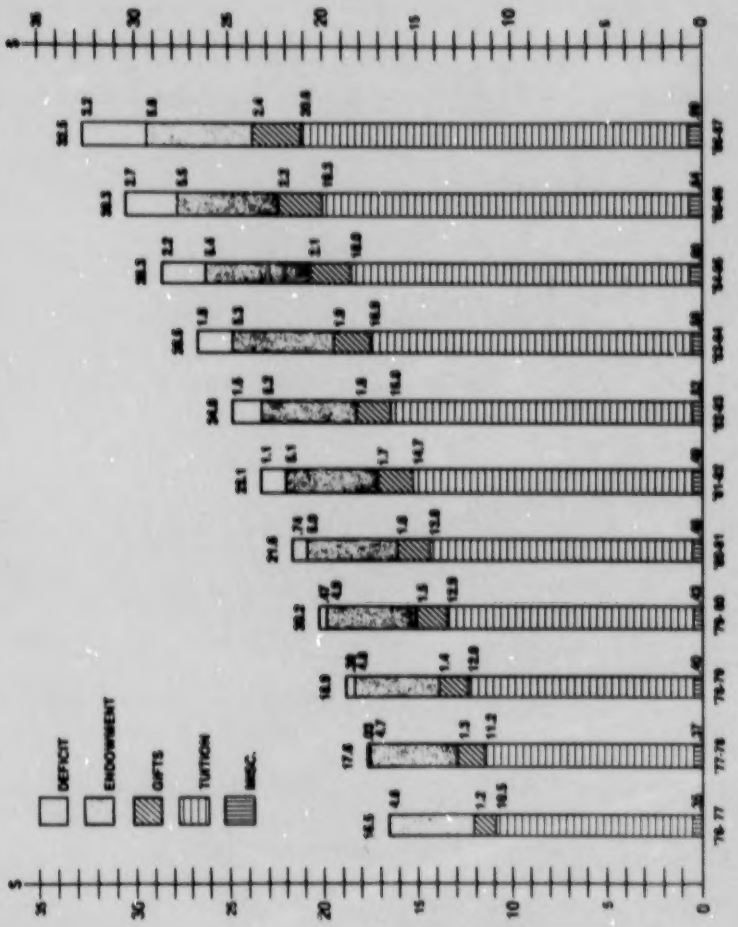


Figure 1. Bar graph presented to Oberlin College Board of Trustees and General Faculty in November-December 1976. *Note: The budget is balanced in 1976-77. Thereafter expenses grow at assumed rate of inflation, 7.0 percent, as do all income sources except endowment. Endowment income grows at 2 percent, the difference between an assumed total return of 8 percent and a payout of 6 percent. This inequality of growth rates produces the ever-increasing deficits shown.*

income had been, and would continue to be, a principal source of financial difficulty for Oberlin. They had convinced themselves, the board, and the faculty that it was crucial for Oberlin to lower its dependence on endowment income and achieve financial equilibrium. They did not, however, know the best method for finding the optimum path to equilibrium.

Some had read the papers of Massy and Hopkins, and a rereading convinced them that the Stanford approach was feasible, if not necessary, for Oberlin. I wrote a FORTRAN program to model the transition to equilibrium, closely following the approach outlined in Hopkins and Massy (1977). Eschewing the more rugged Stanford acronyms of BAP and BEP, this program and its resulting application became known as FEM (Financial Equilibrium Model).

The model assumes there will be a 5-year transition period to equilibrium. At the end of that time, the model budget is balanced, and payout has been adjusted so that the growth rates of expense and income are identical. These conditions keep the budget balanced, or nearly so, in subsequent years.

Input consists of current budget and enrollment data, plus all of the assumed levels and growth rates for the transition and equilibrium period. Output shows the levels of endowment income, all other income, the expense budget, and any surplus or deficit for each of the 5 years. Because payout is being reduced, less endowment income is available for spending, and reductions are required in the expense budget. The model shows the amount of those reductions in each year. They may be scheduled in any manner over the 5-year period.

FEM is not an interactive model like TRADES. The data are read in from a file stored on magnetic disc, and the output produced on a terminal or line printer. However, the program runs sufficiently rapidly that it is possible to change the input data and see the effect over the complete transition period in less than a minute. Particularly with a version that produces only key output figures, the run is especially short. Thus, FEM's actual application is nearly indistinguishable from that of an interactive program.

The College Long-Range Planning Committee, composed of two faculty, two students, and four administrators, and the Trustee Planning Committee spent several months discussing the appropriate input assumptions for the model. A policy decision, made earlier, that there would be no change in student body size simplified both the model and the planning process. We began with a relatively wide range of possibilities for key input parameters, and gradually narrowed them down. The parameter for which the least consensus was reached was the assumed rate of total return on the endowment. Campus planners argued that a total return

of 9.5 percent, the addition of 1 percent through gifts to endowment, and a payout of 4.5 percent, were reasonable assumptions. These assumptions would produce an equilibrium growth in endowment income of 6.0 percent, which it was hoped would be higher than the rate of inflation 5 years hence. However, members of the Board consistently stated that they believed the 9.5 percent figure to be too high. Some of them do not believe that real total return on equities, which has historically been 7 to 8 percent (Williamson, 1975), will continue at that level in the future irrespective of the level of inflation. Nevertheless, when they observed the much larger reductions required from assuming a lower total return, board members agreed to use the higher, perhaps optimistic, figure for planning purposes.

It is difficult to overestimate the importance of these preliminary discussions and the amount of education they accomplished. Those who had no training in economics had to develop at least a rudimentary knowledge of the subject. Faculty participants realized more directly than ever before the extent to which salaries and benefits dominate the Educational and General Budget. It was clear to all that the growth rate of salaries must of necessity remain very close to the overall growth in the budget, and vice-versa. Also, until the 1978 budget discussions, the subsequent year's tuition level at Oberlin had been determined in a somewhat arbitrary way. Now the institution was trying to plan for five years, and some rational, long-range guideline for tuition was required. The Long-Range Planning Committee agreed to use the increase in Median Family Income as a guideline for tuition increases. It seemed eminently fair to raise tuition by the same percentage as the increase in Median Family Income, especially since it was intended that the financial aid budget would be increased similarly. We subsequently discovered that, for the past 25 years, Oberlin's total costs to students had been an almost constant proportion of Median Family income. Unfortunately, Median Family Income figures are not published monthly, although growth in Median Family Income can be estimated from other more current economic statistics. Harvard's use of Disposable Personal Income, which is published monthly, as a guideline for tuition increases is a better approach.

One major difference between the Stanford and Oberlin transition models was the Oberlin de-emphasis of the "funded improvement" concept. It was assumed that Oberlin would not add substantial new programs and facilities, and that required additions would be funded by new endowment dollars. It is possible for a liberal arts college to take such a position; it may not be possible for a major research university to do so.

A successful model allows a number of different assumptions and hypotheses to be tested easily and quickly. At Oberlin, campus planners

were frequently asked what would be the effect if one or another assumptions proved wrong, as we readily admitted they would. We stood ready to test any and all assumptions, and to try any suggested input data, at any time. For example, for a year or two prior to 1978 the Oberlin administration and board had been considering launching a major capital campaign. Many members of the campus community believed that a successful campaign would solve college financial difficulties and obviate the need for further budget cuts. The model easily showed the effect on the annual budget of such a campaign, and it was much less than most thought. Ironically, during 1977 we received the second largest bequest in Oberlin's history. We were able to use the model immediately to show what effect the bequest would have on long-range financial stability.

Figure 2 shows a set of contingency or sensitivity analyses prepared to illustrate the effects on the budget if various assumptions were to prove incorrect. Each parameter was changed as noted while all others were held the same. This chart required only about one half-hour at the computer terminal to prepare.

Eventually we settled on a reasonable set of basic assumptions. As illustrated, the model showed that approximately $800,000 needed to be cut from the budget base, a figure representing 4.5% of the 1977-78 Educational and General Budget. This sum is analogous to the $10.2 million cut by Stanford in their Budget Equilibrium Program. We planned for reductions to be made over a 3-year period, rather than taking the full 5 years of the model. Financial officers of the College felt than an $800,000 reduction was feasible. We believed that the budget base of the college could be reduced by that amount without permanently damaging the institution. For those who were not so apt to view the $800,000 reduction as feasible, we pointed out that, if spread over three years, the reductions amounted only to 1.5 percent per year.

After the reduction figure of $800,000 was chosen, the Long-Range Planning Committee presented the model and its results to the elected faculty councils and sent an eight-page paper entitled *Financial Equilibrium at Oberlin College* to each person on campus. The committee then asked the General Faculty to adopt the following motion:

> That the General Faculty endorses the conclusion of the Long-Range Planning Committee that Oberlin College should attempt to achieve financial equilibrium . . . by 1981-82. The General Faculty understands that this is likely to require reductions in our budget base during the transition period.

As a part of the presentation to the General Faculty, we pointed out that the required cuts could be reduced, or even eliminated, either by raising tuition at a greater rate than had been assumed, or by reducing the

Figure 2. Transition to Equilibrium Model, Contingency Analyses

Change from Basic Assumptions	Sum of Reductions '000	Budget in Year 5 '000	Endowment Start of Year 5 '000
1. None	796	21620	99985
2. Tuition increases at 6.5% instead of 7.5%	1681	20543	101772
3. Tuition increases at 8.75% instead of 7.5%	216	22324	98792
4. Expenses increase at 7.0%	1307	21672	101158
5. Expenses increase at 8.5%	80	21596	99465
6. Total return = 11.0% instead of 9.5%	600	21858	105281
7. Total return = 8.0% instead of 9.5%	984	21390	94887
8. Annual gifts for current operations are $200,000 greater than projected	622	21831	100231
9. Annual gifts for current operations fall $100,000 short of projection	882	21514	99862
10. Enrollment is 2725 FTE instead of 2678	559	21907	100139
11. Enrollment is 2625 FTE instead of 2678	1062	21296	99811
12. Effect of capital campaign is doubled during years 1-5	681	21759	103073
13. Effect of capital campaign is halved during years 1-5	853	21550	98441

planning rate of growth of the expense budget. Campus planners argued that too rapid increases in tuition would be unfair, and might have a negative effect on the College's applicant pool. Reducing the rate of growth of expense budgets would simply produce a number of hidden cust in the form of salaries and support services that grew by inadequate amounts, for example. We argued that it was better to keep the budget growing at more realistic rates and to make the required cuts visible and explicit, even though that also made them larger.

The General Faculty approved the motion above, and, in addition, established the procedures by which the reductions would be identified. As the first step, college administrators were asked to prepare reports over the summer of 1977 showing the probable effect of a 7 percent reduction in the budget of their departments. The 7 percent figure, higher than the average reduction, was chosen because it was assumed that some areas would have to suffer larger than average reductions to permit others to be reduced less, or not at all.

These administrative reports were made available early in September 1977 to the "Area Committees," one of which had been formed for each major segment of the College: Academic Support, Administration, Admissions and Financial Aid, College of Arts and Sciences, Conservatory of Music, Plant, and Student Services. An area committee for Housing and Dining was appointed in December, 1977. These were purposely established in such a way that many cut across traditional budget divisions. Each committee was composed of two faculty members, two students, two administrators, and a nonvoting staff person. They met frequently from the beginning of the academic year until the fall break, reviewing the administrative reports and holding interviews with appropriate persons and groups. Approximately 120 meetings of the individual committees took place. Early in November, the Area Committees issued reports that showed how the 7 percent reduction could be accomplished within each area. These reports were received by a committee composed of the faculty and administration members of the 1977-78 General College, and Conservatory Faculty Councils, the Long-Range Planning Committee, four students chosen by the student members of the individual Area Committees, and two Alumni selected by the Alumni Board, for a total of 37. The "Committee of 37" assigned the task of developing a preliminary report to a smaller working group consisting of 13 of its members. The working group reported back in late January 1978, and the full Committee then wrote and issued to the campus a report entitled *A Financial Plan for Oberlin College*. An open meeting was held to solicit campus opinion, and in April the matter was taken to the General Faculty, who approved the listed reductions. The report was also presented to the Board of Trustees

at its June, 1978 meeting.

Naturally, a number of changes in the starting assumptions occurred over the one-year period during which the reductions were located. These changes are set forth in Figure 3. Fortunately there were both positive and negative changes, and they very nearly offset one another.

It proved less difficult to locate the required reductions than had been anticipated. Many of them (50 percent) could be made in the first year, and several ways were found of reducing the Educational and General Budget without reducing the educational program. For example, we had been returning to the faculty salary pool the difference between the salaries of retirees and resignees and their replacements. Even at a small institution, that difference adds up to a sizable figure over a five-year period. We plan now, with the approval of the faculty, simply to remove these salary differences from the budget base. The model still calls for some real growth in faculty salaries over the transition period.

FEM was run only on the Educational and General Budget because that budget receives all endowment earnings. In the analysis, however, planners discovered that, through the years, a number of items had crept into the Educational and General Budget that really were housing and dining expenses. For example, the salaries of the language dormitory directors were included. When all of these expenses were transferred to the Housing and Dining Budget, that budget began to receive as much scrutiny as the Educational and General Budget.

In 1978 Oberlin is into the first year of the transition to equilibrium period. The required number of reductions have been located, and the appropriate amount of endowment income for the 1978-79 year has been budgeted. The greatest difficulty in developing the 1978-79 budget has been to fit expenditures within the planned first-year growth rate of the model.

It appears now that average inflation over the 5-year period may well be higher than the 5.5 percent figure assumed when the model was developed in Winter of 1977. The higher inflation rate may require increases in the expense budget above those assumed as input to the model, although to an extent they can be offset by increased revenue assumptions, including tuition. Unfortunately, because the published planning documents presented the model in nominal rather than real terms, the community may have difficulty in accepting any changes that become necessary. It appears advantageous in these times of high but variable inflation to present model results in real terms or at least in both real and nominal terms.

Figure 3. Variation in Starting Assumptions, May 1977-June 1978 (in percent, thousands of $, and FTE)

	May 1977 Estimate	June 1978 Estimate	Remarks
Endowment Market Value Projected for 6/30/78	83070	79939	Decline in unit value
Annual Total Return	.096	.095	No change
Gifts to Endowment, 1978-79 to 1982-83	5200	6300	Start capital campaign one year earlier
Gift, Grant, and Other Income, 1978-79	2082	2252	Other Income & Restricted
1982-83	2520	2773	Income Estimates both up
same, General Funds Only			
1978-79	1120	1219	Other Income Estimate Up
1982-83	1392	1512	
Tuition and Fee Income, Less Activity Fee			
1978-79	4.430	4.469	1978-79 tuition up 8.18%
1982-83	5.917	5.968	instead of 7.5%; Health Fee up
Enrollment	2678	2678	No change
Budget Base, 1978-79, General and Restricted Funds	17771	17871	Restricted Expense Up
General Funds Only	16835	16835	No change
Average Growth of Expense Budget, 1978-79 to 1982-83	.063	.064	1978-79 increase 6.97% instead of 6.5%
Percentage of total reduction to be made in 1978-79/79-80/80-81	20/40/40	51/20/29	More reductions possible in year 1 than anticipated
Total Reductions Required	793.7	795.6	Changes nearly offset one another

CONCLUSIONS

In hindsight, it appears to have been critical to the development of the model, and to its acceptance, that both I (Vice President and Provost) and Sam C. Carrier, Director of Planning and Research, had quantitative background and were able to write and understand computer programs. If that had not been the case, neither the idea of financial equilibrium modeling, nor the decision to proceed with it, would probably have occurred. Quantitative background for college officers may not be so important in larger institutions. The latter have more staff, and modeling can involve three persons: 1) a decision maker, who may have no quantitative or computing background; 2) a programmer, who may have very little knowledge of institutional finance and educational policy; and 3) an interpreter, who understands enough of both areas to act as a liaison between the two individuals (see introduction by Wyatt in this volume). However, at a relatively small college, there simply may be no one who can be identified to serve as the interpreter. In order for modeling to occur, either the decision maker or the programmer would also have to act as interpreter. This fact would place certain requirements either upon the selection of the key decision makers, or upon the staffing of the computing center.

Use of a financial model has had several important benefits for Oberlin. Perhaps the most significant is that it accomplished a great deal of education. Faculty, students, and administrators all learned much more about our budget and the factors that affect it.

Second, budget discussions became much more precise. Officers no longer had to talk in general terms about the effect of raising tuition, or of emphasizing a capital campaign instead of the annual fund. The model allowed us to test any assumption or hypothesis quickly and easily.

A third, more practical, benefit was demonstration of the clear need to reduce the endowment payout rate. The model showed us how much reduction was necessary. After three years, the institution will be adjusted to spending 4.5 percent of endowment annually, instead of 6 percent. That reduction, in my opinion, will prove absolutely essential for Oberlin's long-run financial health.

Finally, I believe that we made progress in establishing greater trust between faculty and administration. During the 1977-78 year, the entire budget was opened for scrutiny. Each subcommittee, including the one on administration, was chaired by a faculty member. There were observed to be no protected enclaves, no administrative pets, no hidden agenda. Faculty, students, and administrators all worked together for the good of the entire institution.

All in all, the use of the financial equilibrium concepts and model

helped us to make a major step forward in financial planning, and to raise the financial consciousness and the level of trust on our campus.

POSTSCRIPT – DECEMBER 8, 1978

As noted in the preceding text, FEM does not disaggregate the expense budget, and, although it runs quite rapidly, is not an interactive program. FEM is useful for determining the magnitude of budget reductions required under various starting assumptions, but it does not allow the effects of changes in the values assumed for individual expense categories, such as salaries and utilities, to be readily observed. Neither does FEM allow explicit trade-offs to be tested.

In order to develop a model which does disaggregate the expense budget and allow trade-offs, I began to experiment with the Stanford TRADES model, using Oberlin data, during 1977-78. It was clear that TRADES would perform the desired functions very well, but also clear that it was somewhat Stanford-specific. Before I had invested much time in TRADES, I learned that EDUCOM was developing a generalized version, and I decided to defer further work until I had an opportunity to learn about the EDUCOM version.

The occasion for that occurred during the Indianapolis Workshop, with Daniel Updegrove's presentation and the following hands-on evening sessions. Upon my return I obtained an account on the Cornell System, and began to learn about EFPM. I developed data files on the Oberlin College Sigma 9, with whose editor I was familiar, and sent them on cards to Cornell. It took approximately six weeks, at 5-8 hours per week, to develop the files and to begin to use the system. A portion of that time went toward getting the Oberlin financial data in the form in which I wished to use them in EPFM, and a delay of approximately one week occurred while I waited for my cards to be received and read by Cornell.

This development of EFPM, with its interactive and trade-off capabilities, proved rather timely since at just about the time at which it began to run well, President Carter announced his wage and price standards, and it became necessary to test the effect they would have on our 1979-80 budget. It was very easy with EFPM to develop a "Carter Model" for our budget, plus several other alternatives. These were presented to our central administration, who by this time are accustomed to the use of computerized financial planning models. Their suggestions were used to refine the alternatives further, and the results were presented to our Board of Trustees at their meeting on November 17-18, 1978.

The present Oberlin version of EFPM is quite satisfactory in its detail and flexibility. I do hope to improve it in the near future by adding submodels on financial aid and utilities.

References

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Modeling the Budget at Lehigh University

Eric V. Ottervik

BACKGROUND

Lehigh University is a small, private university in Northeastern Pennsylvania with an undergraduate enrollment slightly in excess of 4,000 and a graduate enrollment of slightly under 2,000. The university includes three undergraduate colleges – Arts and Science, Business and Economics, and Engineering and Physical Sciences – a Graduate School, and a School of Education, which is graduate only. The annual operating budget is approximately $33,000,000. The Board of Trustees expects that budget to be balanced, and it always has been, except for a very minor deficit in 1969.

The university's fiscal soundness is a result of many factors, including a conservative Board and administration, an extremely loyal alumni body, and careful planning. Historically, few, if any, decisions have been made hastily at Lehigh and none have been made without a careful consideration of the financial consequences. Since 1965, the university has attempted to develop further its traditional strengths in engineering, science and business, particularly at the graduate level, while at the same time moving toward parity among the three undergraduate colleges. Attainment of these goals depends on careful planning at all levels and appropriate syn-

thesis of all fiscal, academic, and physical plans. Occasional translation of plans into quantifiable needs and projects led to capital fund drives, also traditionally successful at Lehigh. At the heart of these various successes has always been an individual or group whose leadership and foresight made the success possible.

The world of the 1970's has been increasingly complex and fast-changing. In particular, a host of external circumstances has complicated the lives of all of us – inflation, declining birth rates, government regulations, unionization, student movements, and the relative decline of higher education as a public priority. These factors, and others, have made the need for detailed and careful planning more critical than ever. There is no longer fat to be cut from budgets, and there is little margin for error. For many institutions, a miscalculation can mean closing.

AN EARLIER MODEL

The Need for Modelling

In 1970, because of academic desires to strengthen certain programs and in response to considerable student and faculty pressure, Lehigh studied carefully the possibility of becoming coeducational at the undergraduate level (the Graduate School had always been coeducational). At length, a positive decision was made, and 100 undergraduate women were admitted in 1971. The process that led to this decision included a comparison of the annual operating budget of the university with and without coeducation, projected over ten years, at a specific level of enrollment. A simple question concerning the impact of changing that level of enrollment took two weeks of longhand calculations to answer in detail. That effort, combined with the interest of the Board of Trustees and the chief administrative officers, led the university to develop a computer model of the ten-year operating budget of the university. That model was designed to be: 1) easily understood; 2) inexpensively developed and operated; and 3) quickly flexible to changing assumptions about the university's condition.

Characteristics of the Earlier Model

As a result, a simple model was developed that could be used to project the university's unrestricted operating budget over a ten-year period. The model output duplicated the one-page format of the Treasurer's *Annual Report* in order to maintain a format known and understood by most of the relevant people on campus. That first model also took into account all the assumptions made during the coed study by each academic and nonacademic unit of the University for the six-year period from 1971

to 1976. During those years, 800 women undergraduates were added to an existing male enrollment of 3,200. Other relevant assumptions were also included concerning the imminent beginning of a capital campaign, the completion by certain dates of several new buildings and, most important, parameters relating to increases in average salary, expense, and tuition.

That simple forecasting model, which was not a simulation model but a very rapid bookkeeper, proved to be an extremely useful tool at many levels of decision-making within the university. Because of its simplicity, the model cost very little to develop and only pennies to run. That simplicity was possible in part because of the existing format chosen, which dealt only with large categories of income and expense and which printed out only a few decision parameters. Table 1 illustrates the categories of income and expense included in the model. The decision parameters output by the model were:

Undergraduate Enrollment
Graduate Enrollment
Tuition Rate
Room Rate
Board Rate
FTE Faculty, Instructional Faculty and Support Staff
Average Annual Salary Budget Increases
Average Annual Expense Budget Increases

The simplicity of the original model was also due to the large numbers of general constraints in the university's existing master plan so that many parameters that might have been variables elsewhere were considered fixed at Lehigh. Chief among these was enrollment, which was to remain at 4,000 undergraduates and 2,100 graduate students after 1976. Given the general constraint of a fixed enrollment, there was also assumed to be no change in total faculty or supporting staff and, with a few specific exceptions, no additional facilities. The model produced a simple forecast resulting in a single printout of income and expense totals for a given set of assumptions.

The original model was presented to a wide variety of campus groups and is now quite well known. Over the years, presentations concerning the model were made to the university's Educational Policy Committee, the Academic Dean's Council, the President's Cabinet, the appropriate committee of the student-faculty-administration governance body, the Board of Trustees and two of its committees, and even the student newspaper. These presentations met with mixed success. The typical reaction of the uninitiated group upon being shown a printout sample run was, "Oh, so

TABLE 1. Ten year projection of Lehigh University original model

REPORT DATE OCT. 16 1978	LEHIGH UNIVERSITY BUDGET PROJECTIONS 1978-79 THROUGH 1986-87									
	BUDGET 1978-79	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88
ENDOWMENT	1,750	1,911	1,983	1,987	2,027	2,101	2,214	2,[illegible]	2,383	2,495
TUITION	19,361	20,988	22,648	23,491	25,923	27,939	27,127	28,996	32,384	33,031
PREMISES	1,000	1,761	1,783	1,867	1,952	1,999	2,122	2,078	2,141	2,091
SUNDIARY INCOME	2,681	2,891	2,951	2,887	2,968	2,969	2,983	2,997	2,961	2,988
GIFTS										
OTHER INCOME	1,894	1,994	1,187	1,282	1,239	1,291	1,343	1,[illegible]2	1,483	1,987
STATE GRANT	210	210	210	210	210	210	210	210	210	210
** TOTAL INCOME	29,994 *	30,959 *	31,972 *	32,984 *	34,737 *	37,718 *	39,784 *	42,953 *	44,382 *	45,948 *
INSTRUCTION	9,988	9,949	10,109	10,782	11,438	12,116	12,843	13,614	14,[illegible]81	15,[illegible]78
ORGANIZED ACTIVITIES	18	19	20	21	22	23	24	25	27	28
RESEARCH UNDERGRANTS	12	11	12	13	14	15	16	17	18	19
EXTENSION/PUBLIC SERV	42	44	47	50	53	56	59	63	66	70
LIBRARIES	987	1,088	1,094	1,161	1,249	1,339	1,[illegible]1	1,[illegible]93	1,[illegible]87	1,[illegible]92
STUDENT SERVICES	951	1,088	1,069	1,[illegible]5	1,[illegible]2	1,[illegible]7	1,[illegible]3	1,[illegible]21	1,[illegible]17	1,[illegible]85
PLANT OPERATIONS	2,823	2,781	2,987	3,[illegible]4	3,[illegible]3	3,[illegible]6	3,[illegible]71	4,[illegible]18	4,[illegible]68	4,[illegible]38
GENERAL ADMIN.	1,[illegible]67	1,[illegible]81	1,[illegible]78	1,[illegible]89	1,[illegible]97	2,[illegible]05	2,[illegible]21	2,[illegible]34	2,[illegible]93	2,[illegible]53
GENERAL INSTITUTIONAL	1,[illegible]89	1,[illegible]67	1,[illegible]86	1,[illegible]69	1,[illegible]78	1,[illegible]83	1,[illegible]94	2,[illegible]02	2,[illegible]07	2,[illegible]33
NEW PROJECTS	197	171	197	168	169	198	182	173	170	145
STUDENT AID	2,[illegible]66	2,[illegible]98	2,[illegible]32	2,[illegible]74	2,[illegible]78	3,[illegible]19	3,[illegible]35	3,[illegible]42	3,[illegible]79	3,[illegible]98
AUXILIARY ENTERPRISES	6,[illegible]61	6,[illegible]78	7,[illegible]12	7,[illegible]76	7,[illegible]72	7,[illegible]88	8,[illegible]13	8,[illegible]78	9,[illegible]71	9,[illegible]96
EMPLOYEE BENEFITS	4,[illegible]19	3,[illegible]68	3,[illegible]91	3,[illegible]81	4,[illegible]83	4,[illegible]93	4,[illegible]93	4,[illegible]78	3,[illegible]83	3,[illegible]88
TRANSFERS	198	188	158							
** TOTAL EXPENDITURES	28,[illegible]78 *	29,[illegible]11 *	31,[illegible]82 *	33,[illegible]18 *	33,[illegible]88 *	37,[illegible]88 *	39,[illegible]88 *	42,[illegible]88 *	44,[illegible]28 *	47,[illegible]68 *
NET OUT OF (+)	18 *	15 *	28[illegible]	[illegible]	13[illegible]	[illegible]	[illegible]	18[illegible]	[illegible]	[illegible]

that's what you have decided to do." Thus, the regrettable choice of a particular sample run several years ago resulted in a newspaper headline to the effect that "University Plans $4½ Million Deficit."

In spite of the model's simplicity, there was also a tendency on the part of some to regard its use as a recondite activity cloaked in administrative secrecy. This problem is one of several addressed by the current modeling effort. The obvious, but not always effective, answer to the criticism of secrecy and a closed decision process was clear. A sample was just one computer run out of the more than one hundred that were done each year. Each run was intended to answer a specific "What would happen if . . ." question. One had always to reassure people that the model was not making decisions, but was a tool to aid in the decision-making process. Modeling allowed one to explore the financial consequences of choosing among academic or other alternatives. In fact, many academic choices that seemed financially acceptable in the short run were revealed by the model to lead to dire financial consequences by the end of a decade. The model's inputs were quite detailed for four years and more general for the following six years. There was some pressure to use a five-year planning cycle. However, several runs indicated that it could take as many as seven years for the results of a given decision to show a dramatic effect on the annual operating net.

Use of the Original Model

How was the original model used? In addition to being an ever-present resource for the office of the Vice President for Planning, the model had a far-reaching, pervasive effect on the annual budget-making process. The annual budget for Lehigh is determined by the President and his central staff, with consultation with other advisory groups. Previously, the annual budget, including salary and tuition increases, was determined by combining overwhelming input from the Treasurer's Office on unavoidable increases with a desire to balance the coming year's budget and a very rough guess about the year following that. Academic improvement, even if part of an ongoing plan, fought figuratively for the scraps from the table. More recently, basic academic improvement such as planned faculty increases due to increased undergraduate enrollment became part of the fixed increases considered before the battle began for available funds or, cuts had to be made. The impact of any projected increase was explored over a ten-year period. Finally, and most important for a private institution, the relationship of proposed salary increases to required tuition increases, and vice versa, was explored to try to achieve balanced budgets over the ensuing decade. Fine differentiations between a tenth of a percent salary increase and $25 increases in tution for the coming year commonly were explored

by the President's staff with the aid of the model.

After the budget was decided and approved by the Board of Trustees, it became the base year for the new set of runs that were made during the following year. Each input parameter was also updated. In fact, a second problem related to the original model was the absence of detailed assumptions beyond 1976.

From time to time, submodels were developed to deal with separate areas. Among these were a residence hall model developed because the residence halls and dining services exist as a separate cost center within the operating budget, and a law school model developed to explore the financial feasibility, both capital and operating, of a law school at the University. Primarily as a result of the model analysis, a negative decision on the law school was reached.

The model has had other uses in master planning. As mentioned earlier, planning takes place at all levels, from the smallest unit, academic and nonacademic, through colleges and other larger units, to the institution as a whole. These plans must be synthesized into a whole that relates the academic, fiscal, and physical aspects of each plan. As academic needs become translated into dollar requirements and accompanying space needs become translated into capital and operating dollars, intitial fiscal needs become clear. If the fulfillment of these needs is tied to a capital campaign, the projects may be plugged into the model and their costs projected to see when and in what magnitude capital funds are required. The impact of new buildings on the operating budget in a given year can also be clearly seen. In summary, the need to provide additional income by a given year in order to offset the operating costs of a new building can be emphasized.

Any number of proposals can have their financial consequences explored by use of the model. What would be the effects of changing the student/faculty ratio? What are the effects on financial aid of increasing room rates faster than planned? What would be the real effect on operating income if there were a shift in the pattern of gifts to restricted versus unrestricted endowment? Suppose the football team wins a national championship every year? Over the years, these and many other questions have been at least partially answered by using the forecasting model.

NEED FOR A NEW MODEL

Two major factors combined to force a major revision of the earlier model. These factors fortunately coincided with Lehigh's involvement in the joint Lilly-EDUCOM project. First a major planning effort was undertaken. Reasons for the planning effort included: 1) the lapse of ongoing planning assumptions after 1976; 2) the changed economic and demo-

graphic conditions emerging in recent years; 3) the planned second phase of a capital campaign; and 4) the Middle States Association decadal accreditation visit to Lehigh in November, 1978. By agreement, the Middle States review would be based primarily on the university's long-range planning effort. The effort to develop a revised master plan for the University will result in a document, in large part qualitative, for submission to Middle States. A significant part of the planning process, however, will be the translation of those qualitative plans into numerical inputs for a revised model.

The second factor necessitating a rather complete overhauling of the model was the inadequacy of the previous model. In addition to the "behind closed doors" reaction, other problems resulted from what was at one time the very strength of the model – its simplicity. Desirable simplicity at one stage became undesirable primitiveness at a later point. Parameters such as financial aid and employee benefits needed to be modeled separately within the larger system.

Furthermore, the question of financial equilibrium became increasingly important. During the years from 1971 to 1976, when the university's undergraduate enrollment was increasing by 25%, balancing the annual budget was relatively simple and painless. Although many difficult cuts were made each year, they tended to be reductions in new requests rather than ongoing programs. With the arrival of steady-state or declining enrollment and the current economic situation, achieving a balanced budget for each coming year has become increasingly difficult. Remaining in financial equilibrium is even more difficult. Unfortunately, the original model could achieve equilibrium only by trial and error. If a given run yielded a negative net for any number of years, parameters had to be varied, one at a time or in groups, and new runs made. The process was then repeated until a desired result was approximated. Since the model was run in the batch mode, the process was obviously time-consuming, awkward, and the model was insufficiently flexible.

The simplicity of the model was also a drawback when it was presented to an audience of sophisticated computer users such as faculty members from engineering departments. They often wanted to know why the university was not developing a simulation model based on stochastic processes, regression analysis, or whatever their interest happened to be.

The single biggest problem arising from widespread discussion of the model was, however, the "cast-in-concrete" syndrome. *Not one* group was ever shown a sample run without some of the people involved carrying away three or four pages of computer printout that they thought represented *The Plan* for the next decade, no matter how "far out" the example chosen might have been in terms of bottom-line results.

These drawbacks were very real and had to be addressed. They should not, however, overshadow the great usefulness of the earlier model and its impact, particularly on budgeting. In retrospect, the primary function of the model was to attune many administrators to the use and value of a computerized forecasting model. If Lehigh had attempted to leap initially into use of the TRADES model, it is doubtful that people would have been ready or able to use it effectively. Many administrators and other people exposed to the model had no prior experience in dealing with the computer, and the simple format and virtually linear aspect of many of its calculations were not too formidable.

As Lehigh University began to address the problems raised by use of the original model, several additional problems arose. These problems all revolved around the university's administrative structure and staffing. For purely historical reasons, the earlier model was developed and maintained by the University's Administrative Systems Office. By 1977, that office had neither the personnel nor the time to spend on development of a new model. The Vice President for Planning and Services, on the other hand, had no personnel for this task. Therefore, an initial compromise was struck to try to update and modify the earlier, simple model. This procedure would eventually have been self-defeating by resulting in a model that would have been more sophisticated but also more misunderstood. The resulting model would have been complicated and unwieldy, and still would not have answered any of the public objections to the original model's use and results.

ADAPTATION OF TRADES AT LEHIGH

Fortunately, at this time Lehigh was asked to participate in the Lilly-EDUCOM study. Not only did the availability of the TRADES model save the university the time and cost of initial systems development, but the model's potential struck a positive chord sufficiently strongly to insure the necessary staff time for its adaptation.

The TRADES model with its on-line, interactive capability, permitted a wide variety of users to see the model in action and hence spoke to the "behind the scenes" problem. Most important, of course, the TRADES model permitted instant and internal calculation of equilibrium conditions. The present effort at Lehigh, described below, has involved adaptation of the TRADES model to meet Lehigh's specific current situation and needs.

As the first step, Lehigh decided it would be much more convenient and efficient to experiment with TRADES if it were available on the University's CDC 6400. The program was keypunched from the listing provided by Stanford. The actual conversion was straight-forward. Most

of the changes involved file operations and interactions with the time-sharing system since very little of the TRADES program is machine-dependent. The accuracy of the conversion was verified by using Stanford's variable values to duplicate sample outputs that had been distributed. Stanford's computer was also accessed via Telenet to get some comparative results.

The model was then adapted for use at Lehigh, and two conceptual problems were immediately encountered. First, feasibility criteria for Stanford and Lehigh were different. TRADES relies on endowment payout as a feasibility criterion. At Lehigh, endowment provides such a small part of total income (about 6%) that it was not a meaningful feasibility criterion. For Lehigh, feasibility is more meaningful based on tuition or salary growth.

The second difference involved the variables and their use in various submodels of TRADES. For example, in the Stanford version, salary and expense totals are derived from faculty size and other population-related variables. Lehigh has always started with salary and expense totals and adjusted them depending on projected changes in the population sizes. In the aggregate, now that Lehigh has assumed steady-state, there are virtually no such projected changes.

A variable list and set of mathematical relationships were prepared based on existing Lehigh models and several ideas from Stanford's work. In order to leave room for future new variables and to keep variables logically grouped, the number of possible variables was expanded to 190. About 100 are now in use. The TRADES program was then modified to allow for the new variables, and subroutines were completely rewritten to deal with budget and growth calculations.

Next, the problem of budget feasibility was addressed. Real tuition growth was chosen as the main criterion, but real salary, expense growth, or endowment payout may also be used since provision was made for any growth or rate variable to be used as a "feasibility pivot variable." Four pivots can be specified in Lehigh's version of TRADES using parameter data cards. Initially, the program uses the first pivot specified. A background option is provided to change the pivot variable. Installation of this feature required several new subroutines. In addition, so much of the original TRADES program had been changed or replaced that the main program was also rewritten.

Development of a TRADES model for Lehigh is still going on. Variable values are determined from the current fiscal year budget and estimates for long-term growth rates, and these are stored on a disc file for use by TRADES. When a user starts TRADES at the terminal, the base-year budget is allowed to grow for one year to get a working configura-

tion and budget for the next fiscal year. If feasibility constraints are not violated, the working configuration is adjusted to produce a balanced budget. The first year of growth includes inflation. Thereafter, all monetary results are based on real dollars. The user can get results in terms of actual dollars by using a background option. Although the details are slightly different, the user can then adjust the working budget, examine feasible alternatives and perform projections in a manner similar to the Stanford TRADES.

Even though much of TRADES proved to be transferable, unique differences in Lehigh's environment and philosophy required changing some parts of the Stanford TRADES program. In addition, institutional differences required new submodels that deal with large but discrete areas of the budget, such as employee benefits, financial aid, and residence halls. Coincidentally, these are some of the specific areas that needed more sophisticated treatment in the earlier Lehigh model. Work on these submodels for Lehigh is progressing now. A fourth example of a large budgetary area needing separate modeling is utilities. It is hoped, however, that the problems that have caused this area to merit separate treatment at Lehigh are sufficiently universal to enable fairly complete transferability of a submodel developed elsewhere.

USE OF TRADES AT LEHIGH

Campus-Wide Free Usage

Other significant changes to Stanford's TRADES program have primarily resulted from Lehigh's commitment to public usage of the model. In response to frequent criticism that the original model was a secret administrative tool whose main use was to justify either large tuition increases or small salary increases, or both, the university administration committed to making a version of TRADES totally public by the Summer of 1978. The intent is to have TRADES available in the central Computing Center as a regular program in the center's library. Any person on campus who has access to a computer terminal equipped with a CRT may experiment with TRADES at no cost to the individual user. This procedure will apply to all faculty, students, and staff. More will be said of this step later. The significance of this intent is that usage of the model must be considerably simplified for this purpose. Log-in and log-out procedures must be very simple, and the format of every display and option must be geared toward those with little or no prior computer experience and/or little or no prior experience with financial statements. In addition, as a practical matter, certain options available to the practiced user will not be accessible to the general public, at least at first. It is anticipated that there

may be considerable interest in the public model at first, and, in an effort to insure that users are making comparisons among apples and apples, the ability to look at a given assumption in terms of oranges will be limited. For example, the current Lehigh version of TRADES permits the user to switch at will from real to actual dollars. The concept of real dollars is difficult enough to get across to the initiated. Since uninitiated users may try inadvertently to compare results expressed in different dollars, the public version will use only actual dollars.

As Lehigh's version of TRADES becomes further developed with appropriate submodels, it is anticipated that its use will greatly increase. Of course, the factor that will contribute most to increased use is the interactive nature of TRADES compared to the earlier batch model. When only one deck exists and it is stored in a data-processing office, use of the batch model is obviously inhibited. Currently, a portable computer terminal with a CRT is available in the suite housing the top administrative offices. Physically located at most times in the Office of the Vice President for Planning and Services, the terminal is obviously maximally accessible to him. The day-to-day convenience of the interactive TRADES model naturally results in an increased use. The very low cost per run also facilitates its use. Cost to the user is less than $2.00 for a one-hour session and proportionately less for shorter runs. Hence, many questions that would have gone unexplored in the past are now considered simply at the flick of two switches.

Many detailed scenarios have been explored, and some casual encounters have proved fruitful. Someone may wander into the office unannounced either during a session at the terminal or when time exists to have one. Impromptu sessions can be productive because of the very spontaneity in their approach to trying new combinations of parameters. No dramatic new ways of miraculously balancing the budget have resulted from these efforts, but some valuable new understandings of the relationships among variables have come about. As a prime example, individual faculty members or students have come suddenly to realize the inevitable severe consequences of significant changes in either faculty salaries or tuition when unaccompanied by any other adjustment.

Specific Variable Explorations

Perhaps the most important outcome of the increased availability of the TRADES model, however, has been the use of the option to project a single variable over ten years, in real or actual dollars and as a percent of the total operating budget. With the ease of turning on a pocket calculator, the model can be used to respond to such queries. For example, it took only a few minutes to explore various ramifications of the university's energy-

conservation program: What would our current budget for utilities look like in ten years based on presently projected growth rates? What percentage of the budget would utilities be then compared to now? What would be the effect over the decade of various percentage savings in the next three years because of proposed energy-conservation measures?

As another example: What would be the long-term effect on the plant-operation budget of the completion late in 1978 of the new Athletic and Convocation Center? How would this effect split among salaries, benefits, expenses, utilities? How would potential income affect the long-term picture?

An administrator with responsibilities in other areas should be able to imagine any number of other questions that could usefully be answered. In particular, questions relating to faculty population can be studied easily: What happens if the student-faculty ratio is changed? What if the tenure percentage changes over the years? What would be the effect of an early-retirement policy or, for that matter, of the imminent late-retirement policy? What happens if the number of faculty on the instructional budget changes because of increases or decreases in sponsored research funding?

After specific questions in relatively narrow areas are considered, there remain all the questions involving these parameters in broader issues: What effect might any of these concerns have on faculty compensation? On tuition? On endowment payout? On state appropriations?

Thus, the model is of interest to many individuals, although, at present, only the Vice President for Planning and Services actually operates it among members of the administration. It is hoped that this situation will change when the simpler version of TRADES is made generally available. As a group, however, the central administration does use the model. Because of its experimental nature, TRADES was not heavily used in the 1977-78 annual budgeting cycle. However, everyone involved, especially the President, expressed unease at not having a model available during this period after six years of working with the earlier model. Recent studies indicate that TRADES will be a critical factor in the building of next year's budget at Lehigh.

Political and Educational Usage

The new model has begun to play an important and interesting part in campus politics in terms of its potential to help to educate various student-faculty committees to the realities of current budget problems. Lehigh University has a 125-member quasi-governance group composed of 60 faculty, 60 students, and 5 administrators. The Forum has legislative authority in certain areas and recommendatory and advisory powers in others. Two committees of the Forum – Budget and Tuition – and the

Faculty Compensation Committee have seen the Lehigh version of TRADES. The new model was shown to these three groups to indicate exactly what it is best suited to do – to illustrate the great difficulty of achieving simple trade-offs. For a private institution without a very large endowment, any significant change in faculty compensation is directly proportional to changes in tuition and vice versa. That abstract statement is easy for an administrator to make, but it rarely has much effect on either faculty or students. The point is made quite dramatically, however, when both groups are sitting down together in front of the same terminal and seeing the hard numbers that tell the hard facts. For a private institution such as Lehigh, two points come across. One is that faculty and students have competing dollar interests that are closely interrelated. The second is that faculty salaries and tuition are the two main variables in the equation for a private college at steady-state. In general, neither a major percentage increase in other income items nor a similar reduction in other expense items will provide much leverage on salaries or tuition.

On the other hand, discussions with such groups can also highlight the need for campus-wide cooperation in dealing with such semi-controllable expenses as energy. Again, administration statements about the importance of energy conservation often fall on deaf ears, but, when the dollar impact of a 20% reduction in energy consumption is translated instantly on the CRT into potential faculty salary increases or reduced tuition increases, the message is received quite clearly.

The energy-conservation example is a good one to illustrate one of the reasons for Lehigh's decision to make the TRADES model a completely public and free program in the Computing Center. The university has no "hidden agenda" in its annual budget-making process; the administration certainly has nothing to gain by holding down faculty salaries or by boosting tuition willy-nilly. It is very difficult to gain broad support for budget decisions, however, unless their impact and their alternatives are clearly and widely understood. In addition, in certain areas, such as energy, the help of the entire campus community is needed to try to control costs. Again, the impact of those savings needs to be widely understood in order to gain broad-based cooperation. Finally, someone experimenting with the model might very well turn up some useful information or approach that has been previously overlooked.

Once the TRADES model is a public document, the mystery and mistrust of it and its use will hopefully disappear. The inevitability of certain consequences given certain assumptions will be obvious. The possible trade-offs among the parameters and the possible consequent trade-offs in quality of program, faculty, or students will be visible to all.

As a first step toward this goal, the model was made available in the

Spring Semester of 1978 to the Forum committees on budget and on tuition. In both instances, committee members had a log-in password that guaranteed them free and unlimited access to the limited-option TRADES model described earlier. Both committees were charged with making final reports by the end of March and requested access to the model to explore various alternatives they were examining.

Access was limited to these groups because of the experimental and incomplete nature of the model. By June 1978 it was hoped that the debugging process would be completed and the contemplated additional subroutines installed. The model would then be made available to the entire campus community. It was expected that an initial brief flurry of interest would quickly subside and that the model would actually be used by a few people with intense interests in the budget-planning area. In an effort to advertise the public nature of the new model, the editor of the campus newspaper was invited to two demonstration sessions with TRADES and encouraged to give the model full publicity.

The Model and the Decision-Making Process

In the long-run, the real success of TRADES at Lehigh can only be measured in terms of its impact on the decision-making process. That impact can be clearly seen in one area, but is less obvious in others. The Vice President for Planning and Services will use the model and use it frequently. His studies are made known to his colleagues and will no doubt have a considerable impact on their thinking. For example, at the present time, the Vice President for Student Affairs is discussing enrollment projections and required freshman class sizes over the next four years with the Registrar and the Director of Admissions. Their initial projections were based on an earlier set of assumptions concerning long-term total undergraduate enrollment that assumed a reduction of 100 from the current FTE figure. TRADES projections indicated, however, that a reduction of 60 was all that could possibly be made without violating constraints placed on other parameters, especially tuition. The model's input will change the freshmen quota for the Admissions Office for the next four years.

Similarly, in response to a recent concern about faculty salaries and their future, it was a simple matter to query the model and obtain almost instantly a projection over ten years, based on current assumptions, of average faculty salaries, total faculty salaries and their percentages of the total operating budget, and the tuitions necessary to achieve these salaries given all other income projections. This information will be shared with the Faculty Compensation Committee, which will no doubt request that further alternatives be explored. As that newly elected committee proceeds with its deliberations, TRADES will presumably be very helpful,

since any increase in faculty compensation beyond that currently projected is most likely to come at the expense of something else; i.e., a trade-off.

One other general issue has arisen in connection with the faculty salary projection application of the model. The detail available to a user of the model must be commensurate with his or her level of use; that is, the level of aggregation of the data must be relevant to the user's needs. For example, in overall budget planning, university officers needed only overall institutional data. The Faculty Compensation Committee would like to see the same data by college, while the Academic Deans would also like to see it by department. There are practical trade-offs involved here — how much is to be gained in some instances by gathering data or contriving programming details needed only by special interest groups? On the other hand, if institutional data are created by assembling data from smaller units, the model can reach a broader audience by producing outputs geared to each level of use.

The Lehigh TRADES model, like its predecessor, will have its primary impact during the annual budget-making process. The President and his staff are used to relying on a projection model during this period, and the greatly increased flexibility and sophistication of TRADES will cause it to be an even greater asset in this process.

On the other hand, the less obvious areas of TRADES usage and impact involve both the other top administrators and also the broader campus community. Availability of the model does not guarantee its usage, and the university may be years away from a time when a Provost or a Vice President for Student Affairs turns automatically to his or her own terminal to assess the long-term financial implications of a proposal.

TRADES' SUCCESS AT LEHIGH AND ITS TRANSFERABILITY

The inescapable fact is that political and tactical considerations are of critical importance in the initial acceptance of any model. The model has to provide answers in an easily understandable format to questions that are of current and pressing concern. The model must also be perceived as a controllable tool that the administrator can use to help in making a decision rather than as an inanimate threat to a personal approach to management. In that regard, the model's chief proponent should hopefully be perceived as an individual providing a needed service rather than as an outsider imposing a rigid, impersonal system on others. Therefore, the model might best have as its "home" an office having some direct connection both with the top administration and the academic stem. Part of Lehigh's success in adopting the model as a decision-aiding tool has been its location in a vice-president's office rather than as an offshoot of, for example,

an office of institutional research, the computing center, etc.

It is worth noting, however, that Lehigh has what may be certain unique qualities that facilitate acceptance of modeling in general and widespread use of TRADES in particular. First, and most important, the President is a scientist by training and conversant with computers. His strongly quantitative approach to decision-making has been very strongly supportive of modeling efforts and has permeated his entire staff. Secondly, it must be kept in mind that Lehigh's primary academic strengths for much of its history have been in engineering, science and business.

Lehigh's scientific orientation is reflected in the makeup of the President's staff; The Provost is a chemist, the Vice President for Administration, a metallurgist, the Vice President for Student Affairs, a chemical engineer, etc. Even the Board of Trustees has a high proportion of scientifically and business oriented people and expects an analytical approach to all recommendations. As a result, a numerical approach to decision-making is not only accepted; it is expected. Other institutions, with a less quantitatively oriented administration, might have more difficulty in finding a projection model palatable.

In the final analysis, the impact of TRADES or any other model on the decision-making process in a given institution will depend more on the preconceptions of the decision makers than on the model itself. TRADES is simple enough to use and clearcut enough in its implications to make an impression on most viewers. But the viewer must still have a commitment to planning and to planning based on the best information possible or TRADES may be seen as merely an amusing toy. Preferably, from the President down, there should be an institutional commitment to the use of TRADES or any other model.

Thus, the whole question of the transferability of TRADES comes down to two considerations, each equally important. First, is the one just discussed concerning the institutional commitment to planning. The second consideration is the conceptual basis of the model. Lehigh's experience with TRADES would indicate that many useful insights can be gained by carefully examining TRADES. It seems clear that the basic concepts imbedded in TRADES can be transferred across institutions, although the actual implementation of the concepts will require changing some parts of the TRADES program to accommodate unique differences in each institution's environment and philosophy.

At a finer level of detail, the original Stanford TRADES program is, quite naturally, so rooted at some points in Stanford's own assumptions and own institutional character that considerable programming work is necessary before it can be suitable as a vehicle for transferring the technology from one institution to another.

The overriding advantage of the TRADES model, however, is its general approach and philosophy, which are easily transferrable. The TRADES model can serve both as a catalyst at an institution to awaken its awareness to the need for this kind of quantitative planning and as a model for implementation that can short-cut many costly and time-consuming steps if an institution had to begin from scratch. Perhaps the chief advantage of the TRADES approach is that it facilitates introduction of a quantitative planning approach for many people who would be totally confused or alienated by more exotic and abstruse models. In fact, the whole concept of *trade-offs* is not only valuable but essential for both public and private universities in the current economic climate. As we all attempt to do less for more or more for less, some rational basis must exist to help us decide how best to distribute a limited set of resources. The TRADES approach can be an invaluable part of that process.

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Modeling and Planning at the University of Pennsylvania

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INTRODUCTION

The financial crisis in higher education in general, and at research universities in particular, has revealed the vulnerability of these complex, labor intensive organizations to exogenous influences and has emphasized the need for effective planning. Out of the effort to take control of the unwieldy apparatus of academic policy making, however, has come recognition that even if the fiscal pressures were to ease, the modern university's very complexity has underminded the capacity for administrators to manage and plan. Large institutions have become unwieldy associations of quasi-independent schools and programs. Research centers complement academic departments, interdisciplinary degree programs supplement the traditional disciplines, and entirely new schools emerge to seek their niches in the organizational structure.

The major question for planning in universities is clear: how do we cope with complexity? How do we develop planning and management systems that lead our institutions in the proper direction without overwhelming our analytic and decision-making capacities? At the University of Pennsylvania, we have attempted to structure an environment for planning that

gives to schools and departments a major portion of the responsibility for charting their futures, while retaining centrally the leverage to influence the attainment of the major objectives of the institution.

In this paper we first review the salient features of the Pennsylvania Responsibility Center Management System. We then touch on our early experience with modeling and discuss the construction of information and control systems to support planning. We then present a description of the university's tenure planning procedure in the context of the other planning and budgeting processes of the university. Finally, we summarize some of the general findings resulting from our several years experience with modeling and planning at Pennsylvania, and we comment on the relationship of TRADES and EFPM to those findings.

THE RESPONSIBILITY CENTER MANAGEMENT SYSTEM

In 1973, Pennsylvania reorganized its decision-making and budgeting structure, seeking to balance the traditional independence of academic endeavor against the pressing need for more effective utilization of academic resources. In what emerged, our schools and several other centers including athletics, the museum, the library, and performing arts, assumed responsibility for earning the income generated by their activities as well as for controlling the expenses they were authorized to incur. Under this new decentralized organizational structure, responsibility center management,[1] each school and center carries responsibility for balancing expense with income. By redefining the planning and fiscal responsibilities of each school, responsibility center management preserves the independence of action that schools require while simultaneously encouraging, indeed demanding, more effective use of ever scarcer resources.

The fundamental principle being applied in this move towards distributed management is to get the decision-making at the level where information is available. At this level, individuals can still perceive, if not completely quantify, the combined effects of decisions and actions on understood, but ill-specified, objectives, and they can do so in the face of complex and overlapping constraints. This approach, often termed the profit center model, has found wide application in a variety of industrial and governmental organizations. However, the use of decentralized management in higher education has been quite limited.

Under responsibility center management at Pennsylvania, income generated through the activities of each school is credited, and its direct expenses are charged, to the school. The indirect expenses which support university activity – accounting, maintenance, energy, interest, the cost of the central administration – are attributed to the schools based on the known use they each make of such central services. Given their likely

direct income and their share of the university's central costs, schools are then asked to build budgets in which their total expense (direct plus indirect) does not exceed their total income.

Thus a substantial share of responsibility for income and expense rests with each of the university's separate schools and centers. With this as our strategy, we hoped to accomplish two quite separate goals. First, detailed planning for academic programs would occur at the school level where academic needs, values, and benefits could be identified more clearly. Hopefully, the central administration would retire from the business of making detailed academic decisions, choosing instead to concentrate on the control of central administrative costs and the creation of a university environment conducive to academic development in every school. Central administrators would continue to be interested in the fates of individual departments, but would do so as part of the general oversight function.

Our second goal was to compel the schools to align more closely their aspirations with their resources. As the direct beneficiary of its earned income, each school would presumably exploit every opportunity to increase that income as well as to weigh more carefully the relative merits of new programs. At the same time, once given responsibility for monitoring expense as well as generating income, the schools would learn to operate within a context of accountability rather than evasion. In sum, each school was to develop its own strategy for balancing its budget through income expansion on the one hand and cost reduction and selective reinvestment on the other.

Under the responsibility center management system, the central administration maintained control over the distribution of its general income. By retaining unrestricted resources for distribution to the schools, the president and provost could insure that the objectives of the university as a whole would guide the activities of the schools. University priorities were thus to be expressed through allocations of general income to the schools as a supplement to their earned income.

The difference between direct income and direct plus indirect expense is the net cost of the programs to the central administration. Because this is the net cost of obtaining desirable academic benefits, we choose to call the general funds allocated to cover the cost a subvention. Indeed, responsibility center management holds that the general income of the university – from the direct contribution of the Commonwealth of Pennsylvania, from the university's general endowments, unrestricted gifts, and annual giving – should be raised precisely to help cover such costs. In distributing this subvention pool, university officers take cognizance of two additional facts. First, the unit costs of education for some schools and programs were substantially higher than for others. The teaching of

the natural sciences, for example, is a more costly enterprise than the teaching of the management sciences. Second, some schools have a greater claim on outside resources because of their relationship to the external world, hence a smaller need for support from the general resources of the university.

The implementation of these principles of responsibility center management and their constant adaptation as we learn more about the dynamics of a complex university has absorbed much of the planning effort at Pennsylvania over the last five years. One of the major areas for refinement of the responsibility center system has been in the development and imposition of a tax system. On the income side, all tuition revenues are taxed 20% – somewhat euphemistically termed "University Tuition". The proceeds from University Tuition now provide the major support for subventions and are used in large measure to subsidize the library, museum, athletics, and performing arts which have relatively small and unfortunately constant or declining direct incomes.

In addition to taxing tuition income, we have imposed overhead charges against all of our restricted accounts to help pay the costs for the administration and the space usage necessary to support the restricted activity. Currently endowment income is charged 19.1% and term gifts are charged 10% on expense. The charge on term gifts will be increased gradually to parity with the endowment income charge. A portion of the proceeds of this charge are used to help defray the incremental expenses of a major fund raising drive now in progress. The remaining proceeds plus the proceeds of the overhead charge on endowment income, and the school related portions of the indirect cost recoveries on sponsored research are returned to the school as unrestricted income to be used to help defray the university overhead costs that are charged to the school.

Another feature of the system that has proven to be of major importance is the intercenter bank. At year end, surpluses are credited to the bank at interest to be withdrawn in future years for program support and development. Deficits are implicit loans from the bank to be repaid with interest as a direct charge against the operating budgets in future years. The bank helps to reinforce the incentives in the system for developing new resources and for conserving existing resources for future investment.

It is in this context that planning and modeling have evolved at Pennsylvania. Pennsylvania's distributed organization does not obviate the need for central predictive models such as the Stanford TRADES model.[2] It does, however, change the manner in which such a model might be used.

MODELING AT PENNSYLVANIA

Modeling: A False Start

In 1972, prior to the introduction of responsibility center management, the Associate Provost for Academic Planning undertook what amounted to a cost-benefit analysis of the university. To aid the endeavor, Russell Ackoff, one of the pioneers of operations research, outlined the Program Accounting Model – a set of algorithms intended to simulate the unit costs of academic programs. Data from a detailed survey of how faculty members distribute their effort among classroom teaching, advising, dissertation supervision, research, and administration was to drive the model. By tying information about faculty activity to information on individual salaries, the model would have attributed compensation costs to departmental instructional and research activities. By also distributing the remaining costs of running an academic department (non-faculty salaries, university overhead, and so on) in proportion to the distribution of faculty salaries, the model derived instructional program costs and non-sponsored research costs.

Using a similar logic, and with only minor modifications, the model could link instructional costs of courses to the students enrolled in them, and reaggregate per-student costs into academic majors. The result would have simulated the costs of degree programs.

All of this worked nicely on paper; none of it worked in practice. By 1974 it was clear that a model of this sort and of this complexity was premature, and it foundered on several shoals.

Senior administrators were (and by and large still are) reluctant to initiate comprehensive surveys of faculty activity. Part of their reticence stems from criticisms of similar efforts elsewhere on the grounds of inaccuracies typical of such surveys. At most institutions faculty intensely resent any hint that the character of their academic contributions can be measured quantitatively. As a result, few academic administrators wish to risk the ire of their colleagues by taking such a first step toward cost benefit analysis of academic endeavor. Second, the model demanded more data collection, information processing, and computer programming than the university could make available to the project.

Third, instead of beginning simply, the model emerged full-blown as an elaborate and sometimes opaque set of mathematical equations, and in that form quickly lost its intuitive appeal even to those who commissioned it. Finally, and most importantly, the Office of Academic Planning had begun to turn its attention to issues of more immediate concern: running the responsibility center system.

This negative experience with centralized, predictive planning helped

to provide the impetus for our move to decentralized management. It also helped to set the tone for much of our subsequent planning activity. Our planning now directly reflects our organization, and great care is taken that no model is employed that cannot be readily understood by the decision-maker(s) whom it is intended to support.

Modeling: An Initial Success

By 1974, the university's annual budgeting process, traditionally a technically straightforward but politically delicate task, had taken on new complexity. In previous years expenditure budgets were built by centrally distributing expenditure authorizations based on a projected pool of available resources; now budgets depended upon school-by-school projections of income. Moreover, the university charged each school for its share of indirect costs. Doing so raised a whole new set of issues concerning the equitability of distribution algorithms and the size of the indirect cost pool.

As a result, a series of skirmishes over the accuracy and reliability of the way in which income was accrued and indirect costs charged began to punctuate the annual budgeting process. Moreover, misjudgments and outright mistakes, which in better times would have been absorbed by an expanding resource base, could now make the difference between surplus and deficit. It soon became apparent that the mosaic of interrelated decisions required improved techniques for handling a diverse set of policy options.

In 1974 the Office of Planning Analysis constructed a simple budget projection model. Designed in interactive computer mode, it allows a user, working at a terminal, to enter estimated changes in unrestricted income (such as tuition, enrollment, gifts) and expense (compensation, current expense, and so on). The program then applies escalators and lump-sum changes to the base line unrestricted budget of the university (or, under appropriate circumstances, to a single school) and projects the effect for each of its line items. The model also takes into account interactions between elements of the budget. For example, the model reveals the effect of tuition increases on current financial aid levels and reminds the user when changes in aid are necessary to preserve the current ratio of tuition to aid. Indirect costs present a special problem in a decentralized institution, and the model treats compensation and other expenditure changes in the indirect administrative centers separately.

After completing this initial phase, the model projects the resulting pattern of income and expense for one year, and bottom line performance is evaluated. Should it reveal a surplus or deficit, the model enters a second phase which allows modification of initial estimates by means of a weight-

ing scheme devised by the user. Finally, the model projects the budget and attendant escalators over as many years as the user chooses.

As a model it is simple, automating that which an accounting staff had routinely accomplished by hand. Its contribution to budgeting and planning rests largely on the discipline it imposed on those who built it, for the construction process forced senior administrators to treat as a whole what had over the years become a highly compartmentalized decision process. Crucial variables had occasionally slipped out of sight, only to appear unexpectedly farther down the line. By pulling interrelated factors together, the base budget model made implicit assumptions explicit, and spelled out relationships among variables which previously had been sensed only intuitively.

Modeling: Information and Control Systems Support

The controversy which developed in the budget-building process during introduction of the responsibility center system, though frequently unpleasant, taught us a crucial lesson about responsibility center management: know your institution. We had to know our departments, research centers, and administrative and other central services – what they contribute for what they cost; know our faculty and staff – what we pay them and for what purpose; know our students – where they come from and what courses they take. We saw that the success of responsibility center management depends on the support of a large and well-documented information system and the means to monitor each center's patterns of activity.

For planning and modeling, the pressure for more and better information was to have far-reaching effects. Not only did it improve the data we brought to bear on decision-making, it forced the university to build better mechanisms of administrative control. Out of this early struggle to make the responsibility center system work emerged both the information base and the attendant analytic tools upon which planning and modeling now rest.

Experience has taught us that modeling stands or falls on the information it uses, and, more importantly, that accurate information emerges out of administrative decision and control activities. We did not come to this realization overnight. Because everyone assumed that accurate reporting was built into responsibility center budgeting, the need for a comprehensive information system to support it came as a surprise. We believed that by giving the schools and their departments greater independence they would have an incentive to make sure the information they used was accurate. More importantly, since budgeting and planning were coterminus, the budget units would analyze their own costs of operation. It

just didn't work that way. Deans and schools, unaccustomed to the responsibility of balancing income and expenses and never before charged for their consumption of indirect or administrative services, had little notion of how to budget or to plan.

What the deans needed was better estimates of the impact their decisions were likely to have on the income performance of their school. They also wanted some of their income and expenses stabilized or even guaranteed so that they would not have to be responsible for short-term fluctuations. Two areas in particular concerned them: undergraduate tuition income, which could prove highly volatile under certain circumstances, and charges for university overhead costs. This second concern constituted a challenge to the central administration to keep its own administrative costs under stricter control and hence guaranteeable. Finally, the deans asked for the tools necessary for them to manage their units, to become responsible in the way we all intended.

Income and Expense Reporting. Our first task was to extract from the accounting system a monthly report aggregating patterns of income and expense across accounts by type at both the school and department level. To reinforce the incentives we hoped responsibility center management encouraged, the report used the budgetary categories of income and expense. As with most of our reports, we pursued several goals. First, we wanted to show the aggregate resources available to each department. For too long universities like Pennsylvania had accepted an accounting schema which divided accounts into two categories: unrestricted, often known as the operating or deficit portion of the budget, and restricted, established for specific purposes. In theory, monies in one restricted account can be used only for the stated purposes. In reality, as almost every good department chairman knows, restricted accounts offer considerable latitude. Indeed in most universities, departmental managers deliberately exhaust their unrestricted monies (seen as coming from the university at large and disappearing with the close of a fiscal year) in order to retain in their restricted accounts (which carry forward from year to year) any savings or income windfalls. By portraying all of the resources available to a department, we hoped to make more visible the tradeoff between restricted and unrestricted activity. Indeed, we hoped that once the volume of restricted activity was perceived in the aggregate, good school and departmental managers would begin testing the generalized limits of their restricted accounts and thus find ways of supplementing their unrestricted income.

Our second goal was to demonstrate that departments were responsible for restricted overdrafts in much the same way that they were responsible for unrestricted deficits.

Finally, income-expense reporting was designed to provide, particu-

larly for the deans, some early warning of pending overdrafts and income shortfalls. Where relevant, we calculate projected variances. Some (such as current expense) are based on straight linear extrapolation of spending patterns, and others (including the salary and wage variances) are determined by an actual accounting of past, present, and future commitments. Prior to being reported to the schools, these variances are reviewed by the comptroller's office in order to identify non-recurring spending patterns which, because of their peculiarity, would tend to distort projected surpluses or deficits.

Figures 1 and 2 present examples of budget and operating reports in the income-expense format for a sample school.

Census. Having established an accurate reporting system for aggregate income and expense, we turned next to the problem of a university census. One of the unfortunate facts of university management is that very few institutions of higher education really know who works for them; a myriad of contracts, schools, and special relationships, along with a host of external agencies, make it almost impossible to keep track. Moreover, in many institutions it is often to the advantage of the individual faculty member to obscure as far as possible the sources of his own income. What is known is his or her academic base salary which tenure guarantees. The academic base can be augmented by administrative stipends, evening school courses, summer courses, summer grants, honoraria, and a variety of consultantships and grant opportunities, all of which can be lost in the maze of often archaic personnel practices.

At the University of Pennsylvania, before the introduction of an integrated payroll and personnel system, each separate faculty appointment required a separate entry in the personnel system. Hence, many members of the faculty, particulary those who were active both in research and administration, were separately entered in the personnel records many times, depending on the precise number of secondary appointments. As long as the university was being centrally managed, there was little incentive on the part of either schools or departments to cross-check with each other in terms of total payments to an individual.

The decentralization of fiscal responsibility signficantly changed this pattern. Now school offices, in particular, wanted to know who was paying their faculty (and related staff) how much and for what purposes. In this way, some of the gamesmanship which previously had hindered central oversight and control evaporated. Ironically, such gamesmanship was replaced with increased demands from the schools that the central administration put its personnel system in order.

The basic census, which we developed in conjunction with a new payroll-personnel system, is relatively straightforward. Describing all univer-

Figure 1. University of Pennsylvania Standard Income/Expense Report

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sity members according to a faculty/staff dichotomy, the census further classifies the faculty into three categories: standing faculty (possessing or eligible for tenure), associated faculty (largely dominated by the clinical research and visiting professors) and the support staff (teaching assistants, research fellows, and research assistants). Importantly, the census measures the degree of overlap – the number of faculty who hold secondary appointments, particularly administrative ones carrying stipends. As adjuncts to the census, we developed two supplemental reports. The first shows the pattern of payment to each individual by category of source (summer teaching, administration, and so on) to every member of the university staff. The second, combining the records of the personnel system with the registrar's office, reports on the teaching activity of every individual faculty members, first in directory format and then in aggregate categories based on departmental affiliation and rank. Figure 5 on page 164 is an example of a report drawn from the census data base.

These basic reports – income-expense, the census, faculty teaching analysis and sources of payment – provide the basic information with which the central administration performs its oversight function under responsibility center management. More important, these reports provide the information that the schools require to manage and plan their own resources.

FRAMEWORK FOR FINANCIAL PLANNING

To place the preceding discussion of modeling in perspective, we focus on a school functioning as a responsibility center at Pennsylvania, and we trace the important decisions that the school must make and the information and model support that are available to help make these decisions.

Figure 1 presents a summary of the complete annual budget for a school in the standard income-expense format. The first two columns summarize the unrestricted accounts, and the other columns summarize the various restricted accounts by type (subledger). The several kinds of income and expense discussed previously can be readily identified.

Four Time Cycles for Planning

There are four time cycles of decision-making that have to be supported by information and decision aiding model activities: 1) fiscal year operations; 2) annual budgeting; 3) short-term academic staff planning; and 4) long-term academic (staff) planning. Each of these cycles requires different types of information and support.

In reviewing these four cycles we proceed from the shortest time scale of current operations to the five year time scale of academic planning. In practice, of course, the order is reversed in the sense that the five year aca-

demic planning provides a framework for short-term academic staff planning which in turn frames the annual budgeting and the fiscal year operations.

Fiscal Year Operations. During the fiscal year, a school (center) has some control over direct discretionary expenditures for travel and supplies and the filling of vacancies caused by attrition. It can also hope to influence direct income from students it attracts to its courses, new programs it presents, new gifts it solicits, and new restricted grants and contracts that provide support for expenditures previously budgeted as unrestricted. If however, problems develop in either direct income or expense that cannot be compensated for through operations, the school will run a deficit which represents an implicit loan on the intercenter bank to be repaid with interest through future operations. If the school should run a surplus, the surplus is deposited in the intercenter bank at interest; it can be withdrawn in future years to support questions and/or new program development.

To facilitate control to a balanced fiscal year operation, the school is provided with a host of periodic reports. One of the most useful is the monthly income-expense report discussed previously. Figure 1 is an example of a budget report for a sample school; there is a companion report which presents year-to-date information in a similar format. An additional summary report, shown in Figure 2, projects year-end variances for each of the income and expense items based on known prior patterns of income and expense behavior. Also available on a monthly basis are the detailed reports by account of the individual income and expense transactions processed that month.

Annual Budgeting. The second major time cycle for decision-making is the annual fiscal year budgeting. Here the school must decide, consistent with general university policy, what it can and should do to influence the following income and expense items:

Income	Expense
tuition rates	faculty and staff positions
enrollments	salary and benefit increases
gifts	student aid
overhead recoveries	current expenses
	controllable overhead costs

The annual budgeting process proceeds through several phases ranging from presentation of default outline budgets, to approval of outline budgets, to preparation and approval of detailed account (department or fund) budgets. The default budgets are prepared early in the cycle by the Budget Office for presentation to the centers. They consist of the current

Figure 2. University of Pennsylvania Income/Expense Planning Report

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year income-expense budget from Figure 1 projected forward to include all known and probable changes for next year. These projections reflect university trial guidelines for subventions, tuition increases, enrollments, gifts, salary increases, the effects of inflation, and new overheads. The term "default" stresses that these projections indicate what is likely to happen by default if the school does not take corrective action. Figure 3 presents an example of a school default budget for FY 1979. Although this process was automated in the past, we have temporarily stepped back to a manual system to facilitate more flexible development of standards and procedures. Interestingly, we've found better acceptance of these manual reports as compared to earlier computer output; even today, there is a real aversion to being "planned by computer".

Starting from the default budget projection, the schools then work closely with the provost and the Budget Office to develop an acceptable, balanced budget for the next year. Care is taken to assure that these annual budgets are compatible with previously approved rolling biennial budget plans and five year academic (staffing) plans. In addition, a good bit of time is typically spent discussing the assigned share of general university income (subvention) and the allocated indirect costs. There typically is very little flexibility in these figures, but schools and centers continue to demonstrate real interest in them. A major reason for allocating indirect costs is, of course, to create a constructive tension to improve centrally provided administrative services. Experience suggests that we have been eminently successful in creating tension. We are now working to make this tension more constructive.

Eventually a satisfactory solution is developed, outline budgets are approved, and detailed account budgets and payroll documents are prepared.

Biennial Budget Planning. The third major time cycle for decision-making is biennial budget planning. This cycle has been introduced in response to the observation that annual budget making does not facilitate proper attention to short-term academic staff planning where contracts require at least a full year's notification of intent not to reappoint. This situation meant that the full burden of staff expense reduction fell on administrative and support personnel and only those academic positions that were vacated through attrition. Moreover, although the information was available, so long as there was no official recognition of future problems, the deans kept hoping for a better day and generally postponed even obvious opportunities for academic staff reductions. Biennial budget planning gives official recognition to potential future problems and requires the schools to respond with their solutions with special emphasis on short-term (two to five year) academic staff planning.

Figure 3. FY 1979 Default Budget Projections – Target Surplus = $8.

	FY 1977-78 Budget (9-30-77)	Revisions to FY 1977-78 Budget Base	FY 1978-79 Default Budget	Change (3) Compared to (1)
INCOME (from)				
Total Tuition				
Undergraduate Tuition				
Regular				
Special				
Graduate Tuition				
Regular				
Special				
Tuition from Special Programs				
Special Fees				
Financial Aid Income				
Investment Income				
AIP				
Other				
Over and Recoveries				
Gifts				
Grants and Contracts				
Indirect Cost Recoveries				
Sales and Services				
Miscellaneous Income				
TOTAL DIRECT INCOME				
From General University				
Financial Aid				
Space				
Program -- Durable				
Program -- Soft				
Bank Transaction				
TOTAL INCOME				
EXPENSE (for)				
Compensation				
Academic Salaries				
Administration Salaries				
Clerical Salaries				
Service Wages				
Total Salaries and Wages				
Employee Benefits				
Total Compensation				
Current Expense				
Department				
University Services				
Equipment				
Expense Credits				
Student Aid				
Undergraduate -- Regular				
Undergraduate -- Special				
Graduate -- Regular				
Graduate -- Special				
TOTAL DIRECT EXPENSE				
INDIRECT COSTS				
Student Services				
Operations and Maintenance				
Utilities -- Direct				
Utilities -- Indirect				
Non-Utilities -- Direct				
Non-Utilities -- Indirect				
Auxiliary Enterprises				
General Administration				
General Expense				
Space Allocation				
Direct				
Indirect				
Building Use Credit				
TOTAL INDIRECT COSTS				
TOTAL EXPENSES				
VARIANCE				

This process was first applied for FY 1979 and has been repeated for FY 1980. Figure 4 presents a sample of the forms that went to the schools and centers to start the planning process for FY 1980. Figure 5 is a sample of the support data that was sent to the schools to document the potential freedom to reduce academic staff through retirements and contract expirations. Similar data on administrative and support staff plus backup details on individuals were also sent to the schools and centers. Two years experience suggests that some schools have begun to come to grips with the numbers of academic staff that are both needed and can be afforded to present planned programs.

Academic Staff Planning. The fourth major time cycle for decision-making is the five-year academic (staff) planning. This planning concentrates on projecting the resources that will be available with some confidence (i.e., the durable resources) to support long-term commitments such as tenure. A model was developed to facilitate the process of relating long-term commitments to the available durable resources in each school.

A university makes two kinds of major commitments concerning academic resource allocations; those that commit resources for long-term such as the award of tenure, and those that are reversible over a short-term such as the appointment of nontenured faculty or a planned change in the size of an admitted class. Long-term commitments must be supported with "harder", more durable money than short-term ones.

An appointment to tenure is an obligation on the part of the university to maintain a professor in his or her area of expertise for a period of 25 years or more. Expressed in today's dollars, that appointment is an obligation to expend on behalf of that professor something on the order of one million dollars. No decision in the academic world is so important as a tenure decision, or more difficult to make.

Most university officers and deans will probably never have the luxury of restricting tenure obligations to truly "hard" resources such as endowment. Certainly we at Pennsylvania do not. Therefore, we define as "durable" that fraction of each kind of revenue currently being received that is unlikely to disappear over the long-term. Long-term commitments to staff should not exceed what can be supported by such durable income. Short-term commitments can tolerably be supported by the "soft", or non-durable, income remaining.

The model estimates durable and non-durable income (expressed in constant dollars), for each school based on a five-year historical data base. The central planning problems for each school then become clear: given a five-year projection for general university funds and for durable and non-durable income, what long- and short-term commitments can prudently be supported by these resources? Furthermore, how, over five years, can

Figure 4. University of Pennsylvania Budget Planning Form

	FY 1979 Outline Budget	Revisions to FY 1979 Budget	Escalators	FY 1980 Projected Budget
INCOME (from)				
Total Tuition	[illegible]			[illegible]
Undergraduate Tuition	[illegible]			[illegible]
Regular	[illegible]	[illegible]	[illegible]	[illegible]
Special	[illegible]		[illegible]	[illegible]
Graduate Tuition	[illegible]			[illegible]
Regular	[illegible]		[illegible]	[illegible]
Special	[illegible]		[illegible]	[illegible]
Tuition from Special Programs	[illegible]			[illegible]
Special Fees	[illegible]			[illegible]
Investment Income	[illegible]			[illegible]
E&G	[illegible]		[illegible]	[illegible]
Other				
Overhead Recoveries	[illegible]		[illegible]	[illegible]
Gifts	[illegible]			[illegible]
Grants and Contracts				
Indirect Cost Recoveries	[illegible]			[illegible]
Grants and Contracts	[illegible]			[illegible]
Other (E/L & E/L R)	[illegible]			[illegible]
Sales and Services	[illegible]		[illegible]	[illegible]
Miscellaneous Income				
TOTAL DIRECT INCOME	[illegible]			[illegible]
From General University	[illegible]			[illegible]
Financial Aid	[illegible]			[illegible]
Space	[illegible]			[illegible]
Program -- Durable	[illegible]			[illegible]
Program -- Soft				
Book Transaction	[illegible]			[illegible]
TOTAL INCOME	[illegible]			[illegible]
EXPENSE (for)				
Compensation				
Academic Salaries	[illegible]		[illegible]	[illegible]
Administration Salaries	[illegible]		[illegible]	[illegible]
Clerical Salaries	[illegible]		[illegible]	[illegible]
Service Wages	[illegible]		[illegible]	[illegible]
Total Salaries and Wages	[illegible]		[illegible]	[illegible]
Employee Benefits	[illegible]		[illegible]	[illegible]
Total Compensation	[illegible]			[illegible]
Current Expense	[illegible]			[illegible]
Department	[illegible]		[illegible]	[illegible]
University Services	[illegible]		[illegible]	[illegible]
Equipment	[illegible]		[illegible]	[illegible]
Expense Credits	[illegible]		[illegible]	[illegible]
Student Aid	[illegible]			[illegible]
Undergraduate -- Regular	[illegible]		[illegible]	[illegible]
Undergraduate -- Special	[illegible]		[illegible]	[illegible]
Graduate -- Regular	[illegible]		[illegible]	[illegible]
Graduate -- Special				
TOTAL DIRECT EXPENSE	[illegible]			[illegible]
INDIRECT COSTS				
Operations and Maintenance	[illegible]			[illegible]
Utilities -- Direct	[illegible]		[illegible]	[illegible]
Utilities -- Indirect	[illegible]	[illegible]	[illegible]	[illegible]
Non-Utilities -- Direct	[illegible]		[illegible]	[illegible]
Non-Utilities -- Indirect	[illegible]	[illegible]	[illegible]	[illegible]
General Administration	[illegible]	[illegible]	[illegible]	[illegible]
General Expense	[illegible]	[illegible]	[illegible]	[illegible]
Space Allocation	[illegible]			[illegible]
Direct	[illegible]			[illegible]
Indirect	[illegible]	[illegible]		[illegible]
Building Use Credit	[illegible]			[illegible]
TOTAL INDIRECT COSTS	[illegible]			[illegible]
TOTAL EXPENSES	[illegible]			[illegible]
VARIANCE	[illegible]			[illegible]

Figure 5. University of Pennsylvania Support Data on Staff Reduction Potential

YEAR	CATEGORY	1 NUMBER	2 NUMBER OF FACULTY IN CATEGORY	3 ACADEMIC BASE	4 ESTIMATED PERCENT UNRESTRICTED	5 ESTIMATED SAVINGS	6 ESTIMATED MAXIMUM SAVINGS AS A PERCENT OF UNRESTRICTED A-2 BUDGET
1978	RETIREMENTS	1	102	41	70	91	1
	POSITION NON-TENURED STANDING FACULTY CONTRACT EXPIRATIONS	16	86	000	77	200	4
	TOTAL	17		000		291	7
1979	RETIREMENTS	0		0	0	0	0
	POSITION NON-TENURED STANDING FACULTY CONTRACT EXPIRATIONS	10		001	60	196	5
	TOTAL	10		001		196	5
1980	RETIREMENTS	0		0	0	0	0
	POSITION NON-TENURED STANDING FACULTY CONTRACT EXPIRATIONS	12		230	79	102	3
	TOTAL	12		230		102	3
1981	RETIREMENTS	0		0	0	0	0
	POSITION NON-TENURED STANDING FACULTY CONTRACT EXPIRATIONS	8		67	40	27	1
	TOTAL	8		67		27	1
GRAND TOTAL		47	188	942		616	16

UNRESTRICTED A-2 TOTAL BUDGET FY 1977 $155

current commitments be adjusted to conform with the resource constraints in ways that will significantly improve the academic benefits obtained from the use of the resources?

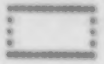
In order to assess the relative durability of each income source, we must determine what proportions of tuition, grant income, endowment return, and the like are really at risk. Experience gained during the last few years serves as the guide for the next five years, but we avoid the simple extrapolation of the past. Since long-term commitments should be conservatively planned, we assume that the worst experience of the recent past (which could very well continue) defines what durable income may be safely posited five years hence. Part of any projected loss, however, may safely be used for short-term commitments. Similarly, we expect healthy trends during the last few years to continue, but recognize that only part of the projected improvement can be safely posited as durable five years hence. One way to illustrate how the model works is to consider the case of an example school.

Incomes. Figure 6 displays income patterns, both historical and predicted, for our example school. Shown are the income components we isolate: undergraduate and graduate tuition; yield on endowments; federal funds, which include direct support, restricted support, and indirect cost recoveries (which accompany all federal grants); gifts and non-federal grants which the school may attract from private donors, foundations, and the like; and sales and services, which in this sample school is very small. Finally, the last line shows program subvention, that share of general university resources which the central administration gives to the sample school to help equalize unit costs and to invest in new academic programs. These incomes are normalized to constant dollars (in this case to FY 1977 dollars using the GNP deflator).

Undergraduate income in constant dollars is increasing in this school quite dramatically; it has increased by some $1.1 million in three years. We believe that for such consistent income growth, 90% of the final result can be regarded as durable and the rest is at risk. Graduate tuition in our sample school similarly reflects consistent growth and consequently substantial durability. If, in a year or two, either of these sources were to decline, the model's annual iteration would reduce this durable income figure. The use of a five-year horizon provides the time to make adjustments in commitments.

This school's use of endowment income has decreased considerably during this four-year span in constant dollars. In FY 1974 the school spent $572,000 in available funds, but only $438,000 in FY 1977. This suggests to us that a portion of the $438,000 is at risk. If the income has slipped once, it may do so again. Consequently, we say that in five years this in-

Figure 6. University of Pennsylvania Sample School Income Patterns

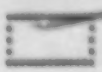


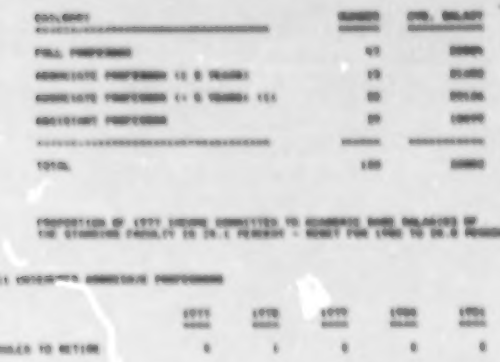
come will be somewhat less than $438,000. The difference can be used as non-durable income for commitments from which the school could extricate itself in a year or two if necessary.

Program subvention reflects the central administration's current view of what it believes this school's share of the general resources of the university may be five years hence. We have been prudent about the expected size of these subvention resources. This amount represents not only the decision about this school's share, but also an estimate of the entire university subvention pool in constant dollars. For the school as a whole, resources are expected to continue to grow. The school had $15.7 million total income in FY 1977, and we project in 1982 $13.9 million as durable. Another $3.8 million is at risk, and total income projected for 1982 is the sum of the durable and non-durable totals or $17.7 million.

How are these resources now being used? What do they tell us about the future of tenure in this particular school? Figure 7 shows the status of the school's faculty at the present time, and reveals that there are 47 full professors earning an average academic base salary of $30,500 a year (not including benefits). Fifteen associate professors have been on the faculty in that rank for five years or more and 32 for less than five years. Note that the average salary of the latter group is higher, probably because associate professors who have been in that rank for more than five years are less mobile. The total faculty numbers 133 at an average academic base salary of $23,852 a year.

Figure 7. University of Pennsylvania Sample School Faculty Status





From the outset we have assumed that over the next five years the proportion of a school's income currently devoted to its tenure-significant faculty will remain constant. To calculate this proportion for our sample school, we took the sum of all academic base salaries (for 1977) currently committed to tenure-signficant faculty and divided by the total income for the school. This school today spends 20.1% of all its resources on salaries for its standing faculty. (This is a small figure; in most schools at Pennsylvania the fraction is about 30%.) The remainder is spent on activities that support the faculty, including technicians, secretaries, clerks, equipment costs, computer costs, school administration, and for general university overhead costs.

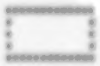
Finally, Figure 7 reports that only one faculty member is scheduled to retire by 1982, a situation which is typical of the age pattern in higher education generally. It is clear that as this faculty ages and matures, it will impose constraints on the kinds of tenure commitment that can be made in any given five-year span.

Faculty Flow. A basic assumption at Pennsylvania and at most universities has been that as an individual progresses through the academic ranks from assistant to full professor, his or her relative salary will rise. We assume further that each member of the faculty who has been an associate professor for at least five years will be a full professor in 1982, and that a school's average salary for each rank will remain constant in constant dollars.

The net effect of this assumption in the case of our sample school has been to increase the tenured salary commitment even though the number of tenured faculty declines slightly in FY 1978 due to retirements. As the faculty matures, almost no one retires, and the resources the school must spend on its faculty inevitably increase even without the addition of new faculty.

Tenure Guidelines. Figure 8 reports that 83 of the 133 faculty in the school now have tenure. Allowing for retirements, there will be 82 tenured members of the faculty by 1982. If the trends that define this projection persist, and if the school does not change the proportion of resources it expends for tenure-significant faculty, we can say that the *durable* income of the school could support 104 tenured positions in 1982.

Figure 8. University of Pennsylvania Sample School Tenure Profile



Prudent Staffing Levels. In Figure 8 we report what happens in the school at two extremes: 1) if no new promotions to tenure are made; and 2) if every available tenure position is filled. How much should be committed is a matter of policy best left to the school and the provost. For planning purposes, we have defined a prudent tenure level as halfway between "no new promotions" and "the maximum number of promotions."

The uncommitted durable income along with the proper proportion of non-durable income then becomes available for new assistant professor appointments. It is important to emphasize here that the 22 tenured positions frame the decision process for the school. The school, subject to approval by the provost, decides how resources actually will be spent. Indications of tenure freedom by the model do not constitute a license to grant tenure. Rather, they help the school quantify its five-year academic plan in terms of tenure positions. The model results are also used by the provost and his advisors in testing the validity of the academic plans of the schools.

During FY 1979, and each year thereafter, we will reexamine actual experience and modify the projections on the basis of established facts. We have opted for a rolling five-year planning process, one which we iterate each year. In FY 1977 each school was asked for a five-year plan for the use of its durable and soft resources through FY 1982. Next year, based on another year's experience, we will revise our estimates of durable and soft income if necessary, and require a modification of the plan if that too proves necessary.

This procedure for academic staff planning illustrates the manner in which modeling supports the search for a viable future. We begin with the premise that planners can model a part but not the whole of any policy process. Thus the model focuses on the issue of fiscal resource allocation; specifically, the commitment to tenured faculty. Second, our procedure deliberately allows for maneuverability on the part of both the deans and the central administration, by setting parameters and establishing guidelines within which the policy process can proceed. In short, it leaves room for choices. Third, our procedure is flexible, both in our ability to modify it structurally on short notice and with considerable ease, and in its ability to tailor its product to the unique character of each of the university's thirteen schools. Fourth, its structure and logic are straightforward. Finally, and most important, the model attempts to build incentives into the planning process by showing precisely how changes in the way a school allocates its resources and raises revenues can change its opportunities to commit resources to tenured faculty.

We accept, however, that neither this simple calculating technique nor the subsequent analyses allow us to claim prescience. Thus, in framing the staffing plans required by the provost, we use our analyses to establish benchmarks rather than to make precise judgments.

While this tenure planning approach is still new to Pennsylvania, the following interesting and valuable results have already been achieved:

1. There is now general recognition that the awarding of tenure in a school must be linked to the durable resources earned by that

school.

2. Recognition is emerging that tenure is not a right of the best junior faculty, but rather a resource to be employed sparingly to attract the best *available* scholars – hopefully from within the institution, but not necessarily.
3. The administration now recognizes that the five-year durable subventions mean nothing unless the subvention resources are maintained at constant or increasing levels and overhead costs at constant or decreasing levels (in constant dollars).
4. The schools have begun to recognize that they can improve their future tenure capacity through additional income generation and lifestyle alteration.
5. Almost everybody now accepts (albeit reluctantly) that durable resources cannot be based on estimates of future pledges, desired future gifts and grants, and possible future interschool reallocations.
6. This approach provides an excellent basis for planning subventions because the consequences of reallocation can be measured in a readily understood academic unit, i.e., number of faculty.

MODELS AND PLANNING

Modeling Principles

Several principles to guide modeling have emerged from our experience. First, is the recognition that planners do not make decisions, they support the decision process. Administrators make policy, and the task for planners is to create an environment in which senior administrators can effectively choose among alternatives.

Second, strategic planning, like all decision-making, is fundamentally a process of negotiation. Because the circumstances that surround strategic decision-making change constantly, policies do not emerge fully formed, they evolve. Good planning takes on the flexibility, the capacity to adapt to changing opportunities, and the straightforward decision criteria that characterize practical policy-making.

Third, planners who wish to play a central role under these circumstances must regularly sit at the negotiating table, in part to see that debate rests on realistic assumptions and sound information, but primarily to gain insight into how policy-makers perceive the options and constraints before them.

Fourth, the most effective planners must demonstrate ability to support short-term policy-making. Indeed, their credibility for long-range astuteness will be a direct function of the success with which they support the more immediate demands of short-term problem solving.

All of this holds implications for models and model building. Just as planners need to take on an adaptive style, so must technical tools. Like effective planners, effective models in a sense enter into the give and take of policy debate.

Model Building

In the rush to tell the world about the latest in modeling advances, planners sometimes forget that their most persistent problem has always been to integrate their instruments into the policy process. The acid test for any planning model is "How many policy decisions are different by virtue of its contribution?" Or, simply, "Are policy-makers using it?" The task for model builders is clear. They must integrate their technical tools into the process of negotiation that surrounds policy-making, engaging them in the ongoing debate over courses of action. The best models can respond readily to unanticipated changes in the relationships they express; the more easily they can move with the flow of policy-making and respond to external pressures, the greater their chances for success. Here packaged planning instruments demonstrate built-in shortcomings. Burdened with fixed assumptions about the structure of problems and the best way to evaluate alternatives few can provide the kind of flexibility that strategic planning demands.

Because the most effective models mirror and evolve along with the perceptions of those who use them, it follows that any effort to build instruments for planning must include strategies for making the end product compatible with the way decision-makers think. Administrators prefer decision support devices whose inner workings they full comprehend. Uncomfortable when the conceptual underpinnings of a tool elude them, few leaders will pursue policies important to the future of an organization according to the dictates of theory with which they are not comfortable.

All of this suggests that those who want to improve the manner in which their institutions plan will place a larger part of their energies into building their own, institution-specific and necessarily unique, analytical tools rather than adopting the planning models of some other institution.

Interestingly, the new financial planning model being developed by EDUCOM is well matched to this philosophy. Instead of implementing a rigid modeling structure, EFPM[3] provides an environment for financial planning into which institutions can insert models tailored to their own characteristics.

CONCLUSIONS

This review of the underlying philosophy and of the models and in-

formation systems employed to support the Pennsylvania Responsibility Center Management System should reinforce a previously stated hypothesis: a distributed information system can provide an effective structure for managing an organization as complex as a university. The models necessary to support such a system can be extremely simple because of the continual updating and inherent stability afforded by the management structure. Moreover, the outputs of these models are interpreted by the very people who constitute the management system. These people will be the first to recognize problems with a model and, with proper support, will be in the best position to effect solutions. The key to the effectiveness of the responsibility center management system and its decision-making aids is the inherent simplicity. All eventualities need not be accounted for in the predictive models because the informed person(s) best suited to take appropriate action are involved in using the models and recognize their limitations.

In TRADES,[4] we see a model developed to suit the organization and management style of Stanford. At Pennsylvania we have taken an alternative and, we believe, equally successful approach to seeking and achieving a viable future.

Footnotes

1. Straus (1976).
2. See chapter three in part I of this volume.
3. See the first chapter of part II of this volume.
4. Ibid.

Reference

Straus, J. C., et. al., "BUDGET MANUAL – Responsibility Center Management System", University of Pennsylvania, Philadelphia, 1976.

9

Financial Planning at the State University of New York - Albany

Robert C. Shirley, Wendell G. Lorang

A PROFILE OF SUNY-ALBANY

The State University of New York is the largest system of public higher education in the world. Comprising 64 campuses, it enrolled approximately 340,000 students in Fall 1978. By type, the constituent campuses include: 30 community colleges; six agricultural and technical colleges; three specialized colleges; five statutory colleges; 14 arts and sciences colleges; two health science centers; and four major university centers (Albany, Binghamton, Buffalo, and Stony Brook). The four university centers account for about one-sixth of the total SUNY enrollments.

Founded in 1844 as the State Normal School, the Albany campus was designated in 1962 as one of the four major universities to be developed in the SUNY system. By 1971, the institution was offering 49 baccalaureate programs, 52 masters programs, and 28 programs at the doctoral level. These programs covered a full range in the humanities, fine arts, social and behavioral sciences, natural sciences and mathematics, and selected professional fields (business, criminal justice, education, library and information science, public affairs, and social welfare).

The Albany campus enrolled 14,700 students in Fall 1978, one-third of whom were pursuing advanced work at either the masters or doctoral level. The operating budget for 1978-79 was $46 million, and external research funds amounted to an additional $11 million. The student/faculty ratio is approximately 16:1, and demand for entrance to the university is extremely high. In Fall 1978, 13,000 applications were received for the 2,000 freshman places which were available; the average entering freshman was in the upper 13 percent of his/her high school class and had a cumulative average of 90 upon graduation from high school. Because physical facilities are at capacity, the campus does not plan a significant increase in enrollments over the next decade.

THE DECISION-MAKING ENVIRONMENT

As is the case with all public universities, the Albany campus operates within a complex milieu of external factors and forces. A brief description of the external factors is presented below, followed by a summary of the internal organizational arrangements for planning.

External Factors/Forces

The overall operations of the campuses of the SUNY system are coordinated by a central administrative staff. Numbering roughly 300 people, SUNY-Central establishes broad policies in academic affairs, finance, research administration, personnel, legal affairs, and other areas in order to effect system-wide coordination. The policies are generally rather broad, thus leaving individual campuses with a great deal of flexibility and autonomy to manage their own operations. Each campus in SUNY is subject to a variety of operating constraints in the financial area, but the vast majority of these originate in the various agencies of state government.

The governmental agencies most active in controlling the financial operations of each campus are the Division of Budget, Audit and Control, and the Office of General Services. Each of these agencies engage in both pre- and post-audit activities which result in a vast overlay of controls on financial operations.[1] The agency most concerned with long-range financial planning is the Division of Budget. This agency works with SUNY-Central and with individual campuses to establish annual operating budgets and to discuss (albeit infrequently) the multi-year implications of those budgets. Because the Division of Budget is also responsible for budget control throughout the year, it has developed an elaborate set of procedures to govern financial transactions like transfers of funds across budget categories and financial policy like salary levels for different types of positions. The staff of this agency is generally regarded as quite competent, an elite

group within New York State government which has played a primary role in developing solutions to the fiscal problems which have plagued New York City.[2]

Through the Division of Budget, the governor makes his recommendations on funding for each SUNY campus to the legislature in January of each year. Both bodies of the legislature, the Senate and Assembly, have developed their own staffs to assess budgetary needs of the campuses. These assessments are carried out through a process of interaction with the Division of Budget. However, only rarely is there direct interaction with officers of the individual campuses. The legislature makes its appropriation to each campus on April 1, the beginning of the fiscal year in New York State.

In summary, there are a number of governmental bodies which exercise control over the financial operations of SUNY campuses, but the most important constraints are exercised by the Division of Budget and the two houses of the legislature. All three bodies have operated, for the most part, in a one-year context, although there are increasing efforts to examine the multi-year implications of annual budgets.

Internal Organization for Planning

The following paragraphs describe the status of planning efforts at SUNY-Albany prior to the installation of President Emmett Fields and our involvement in the financial planning study.

Academic Planning. Prior to 1975, the academic planning efforts at SUNY-Albany were conducted almost exclusively at the college, school, and department levels. Faculty recruitment priorities were addressed, along with other developmental needs, in one-to-one interactions at successively higher managerial levels. The discussions were supported by annual reports and by staff work on enrollment trends, workload, and faculty characteristics. External consultants' reports on program needs were also available.[3]

It was not until the Spring of 1975 that a campus-wide review body was established to assess the quality and developmental needs of all programs in a systematic fashion. This body, the Select Committee on Academic Programs and Priorities, was appointed by then President Louis Benezet in anticipation of declining resources in the future. The Select Committee's deliberations resulted in recommendations for program improvement and reallocations, as well as the termination of eight degree programs. President Benezet later resigned, but the recommendations of the Select Committee were implemented by his successor, Emmett B. Fields, in the Summer of 1975.

Approximately six months after the Select Committee had presented

its report, the governor recommended to the legislature that the budgets of all SUNY campuses be reduced. In response to these recommendations, President Fields appointed the Presidential Task Force on Priorities and Resources to advise him on where, and how, the reductions might best be accomplished. Eschewing an "even-handed, across-the-board" approach, the Task Force recommended the deletion of 20 degree programs, thus freeing up the positions necessary to meet the mandated budget reductions as well as releasing an even greater number of positions for reallocation to the programs remaining on campus. President Fields accepted the recommendations and authorized their implementation in March 1976.

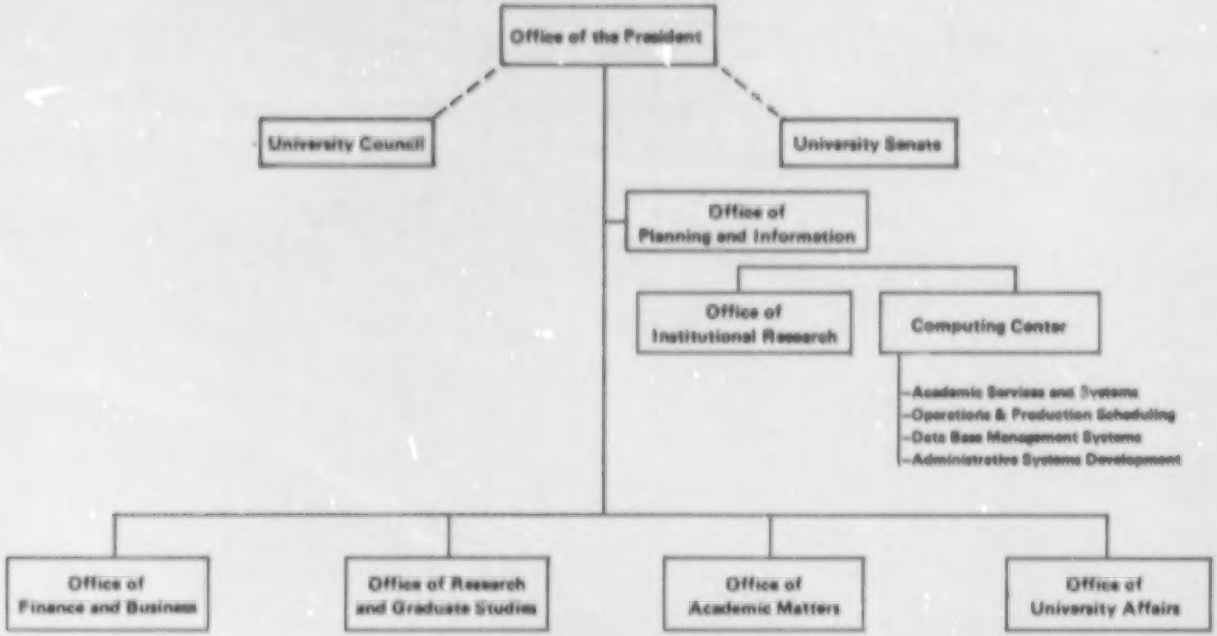
While far-reaching in scope and impact, the academic planning efforts of the Select Committee of 1975 and the Presidential Task Force of 1976 were, nonetheless, ad hoc efforts that were not the style of the new president. Within several months of his arrival, the Office of Planning and Information Systems was formed, reporting directly to the president (Figure 1). The Director of Planning and Information Systems now plays the lead role in coordinating the long-range academic, financial, and facilities planning efforts of the campus and attempts to insure both intellectual and logistical integration of the various tasks to be performed. A necessary first step, given the relative youth of the campus and the absence of both a planning process and overall goals, was definition of the mission of the enterprise. Following extensive campus review and discussion, a document entitled Mission, Programs and Priorities for Action was developed and issued in July 1977. This document established the planning parameters for the campus and provided the frame of reference needed for multi-year academic and administrative planning. Each unit of the campus now prepares three-year development plans that are reviewed and updated annually.

Facilities planning. A process has recently been established to insure that decisions on space reflect the priorities of the campus. It is a virtual certainty that only a limited amount of new construction will occur on the Albany campus; thus the primary avenue available for satisfying the space needs of high-growth programs is through reallocation of existing facilities. A Space Management Committee was established in 1977 to formulate the process through which space could be managed and reallocation decisions made consistent with the plans of the campus.

Financial planning. At SUNY-Albany there are two major types of financial plans: capital and operating. Reflecting the no-growth facilities plan, the annual capital plan focuses almost exclusively on alterations that are required either for modernization or because of a reallocation of space from one unit to another.

The operating budget plan is more complex, of course, and always has

Figure 1. State University of New York at Albany - Organization Chart 1977-1978



been prepared in a one-year context. Moreover, the budget philosophy always has been an "incremental" one, although some ad hoc analyses are done in a manner which could qualify for a "zero-based" label. To a large extent, this one-year focus in financial planning results from the one-year time horizon of the external bodies alluded to earlier; for example, the formats for budget preparation which are developed by SUNY-Central rarely ask for multi-year projections. Similarly, allocations within the campus are made for one year only, although longer-range considerations related to program development and enrollment trends have begun to influence short-range budgets. In general, no systematic attempt had been made to project long-range financial needs and resources prior to the campus' participation in the Lilly-EDUCOM project.

EVENTS LEADING TO MODEL DEVELOPMENT

In January 1976, President Fields was asked whether or not SUNY-Albany would like to participate in the Lilly-EDUCOM financial modeling effort. Being a strong advocate of planning and the application of computerized techniques, President Fields enthusiastically endorsed the effort. Moreover, the timing of the invitation to participate was propitious; it came on the heels of the mandated budget reductions discussed earlier in this chapter.

The Albany campus had little previous experience with computerized financial planning models, much less those which focused on a distant future. However, the capability did exist to undertake the modeling effort; several members of the middle management team were familiar with computer applications (albeit mainly for transactional purposes), some prior work had been done with NCHEMS models, and the necessary computer hardware was available. The Director of Planning and Information Systems was assigned responsibility for the project, and it was agreed that the potential benefits of the effort would, if realized, exceed the costs. The primary benefits seen at that time were: 1) the existence of a tool to help demonstrate the needs of the campus to various external agencies (for State support) and to individuals (for private support); 2) the increased credibility which would accrue to the campus as a result of its being able to rationally state, and defend, its budgetary requirements; and 3) the development of a means for translation of program plans into multi-year dollar requirements.

DEVELOPMENT OF THE MODEL

The Director of Planning established a project team of six persons including himself to conceptualize and implement the forecasting model. The other five individuals were the Vice President for Finance and Busi-

ness; the Director of Administrative Systems Development; the Director of Institutional Research; the Research Associate in the Office of Institutional Research; and a graduate assistant hired especially for the project. As illustrated in Figure 1 on page 177, all of these individuals reported to the Director of Planning except the Vice President for Finance and Business.[4] The team began with a review of the basic financial environment of the campus.

The Financial Environment at SUNY-Albany

The primary source of revenue for the campus is the state appropriation. Tuition and fees collected by the campus are "passed through" to the state's General Income Fund, and room charges are similarly passed to the Dormitory Authority which built, and retains title to, campus residence halls. However, residence maintenance and operation is a campus responsibility, and funds for this purpose are included in the annual appropriation from the state. All other auxiliary operations are administered by University Auxiliary Services (UAS), an organization which is financially independent from the state and the university. Capital amortization and fringe benefit costs are not part of the campus' budget, as these items are included a lump sum appropriation to the larger SUNY system.

While there are non-state funds coming into and being expended by segments of the university community (e.g., individual faculty research funds, Student Association, University Foundation) these funds are not in direct support of "mainline" campus responsibilities (the operating budget), nor are they under the direct financial control of the administration. Thus, such funds are "restricted" at the level of campus administration, though they may be unrestricted at the level of the project director or unit which has obtained the funds. The project team decided to exclude all non-state funds from the initial model since they are not normally considered when building the operating budget.

The state appropriation for operating purposes is categorized by Major Purpose and Function (see Figure 2) and by Object of Expenditure such as personal service, temporary service, supplies and expenses, and equipment. The appropriation is not a lump sum amount which the campus can allocate across categories as it sees fit. With prior approval, funds can be reallocated to and from a given Major Purpose, but such reallocations cannot exceed five percent of the appropriation for that Major Purpose. Movements of funds across Objects of Expenditure are generally possible only in the supplies and equipment categories which, for the most part, are interchangeable. Although these kinds of restrictions are common to nearly all public institutions, it is probably safe to say that restrictions on financial management at the campus level are more severe in New York State than in other locales.

Figure 2. New York State Appropriation Categories

MAJOR PURPOSE	FUNCTION
I&DR	Instruction and Departmental Research (I&DR)
Organized Research	Organized Research
Extension and Public Service	Extension and Public Service
Academic Support	Organized Activities
	Libraries
Student Activities	Student Services
	Student Aid
	Maintenance and Operation
Institutional Support	General Administration
	General Institutional Services
Housing	Housing

Basic Framework of the Model

A five-year forecast of expenditures and revenues was the first task. For reasons noted earlier, the initial forecasts were restricted to state-appropriated funds. It was assumed that there would be no program improvements or changes in enrollment for the campus as a whole, i.e., that the "steady-state" resource environment would continue over the five-year period covered by the forecast. This assumption was realistic because SUNY-Albany had reached its maximum physical capacity at the time the forecasts were being prepared.

The level of aggregation chosen for the five-year forecast reflected the State appropriation categories of Major Purpose, Function, and Object of Expenditure. As noted earlier, a major reason for developing the model was to demonstrate budgetary needs to State authorities, hence the attempt to use categories familiar to those authorities. These categories also reflect the level of aggregation at which the president and vice presidents make decisions on allocation trade-offs during the annual budgetary process on campus. It should be noted that the campus decision process on budget allocations extends well below this level of aggregation (for example, to the colleges and schools within the Instruction and Departmental Research category), but the functional break-down is the starting point. Thus the basic model structure chosen was congruent with the needs of both campus decision makers and external authorities.

Fiscal 1976-77 data were used as the baseline for the five-year forecast. An extensive review of these base year figures was conducted in order to identify any atypical fluctuations in the data and determine the mix of

items within a given Object of Expenditure. The "mix" of items is important for determining the price increase assumptions. Prices for laboratory supplies, for example, differ significantly from those for office supplies, but they are both categorized as "Supplies and Expense" in the basic model. Thus the final price increases assumed for each Function and Object of Expenditure were weighted to reflect the relative proportions of various types of expenditures. A discussion of how these estimates were developed is presented in detail in Appendix A.[5] The final expenditure growth rates used in the model for the various Functions and Objects of Expenditure are shown in Figure 3.

RESULTS OF INITIAL FORECAST AND SENSITIVITY ANALYSES

Figure 4 through 7 summarize the results of the initial forecast. Table 4 indicates, by function, the projected expenditures through 1981-82, *assuming no real growth in existing levels of activity*. Thus, the Albany campus operating budget would, by 1981-82, need to be approximately $60,000,000 in order to maintain its current volume, and quality, of programs and services. Figure 5 also indicates projected expenditures through 1981-82, but by Object of Expenditure for the campus as a whole. In order to provide the necessary funding for the needs depicted in Figures 4 and 5, the state appropriation for operating purposes would need to increase by 6.66% per annum over the next five years.

Given the current fiscal problems confronting the state of New York, an average annual increase of 6.66% in the campus appropriation appeared unlikely. Indeed, the state appropriation to the campus had grown between only 3 and 4% over the last two years. Figures 6 and 7 identify the deficits projected assuming that revenue grew at only 2% for non-salary items, and 2.5% and 6.1% for instructional and non-instructional salaries respectively. The revenue assumption for non-salary items was the average of revenue growth for the last two years, while for the salary items it was an estimate of the impact of the then recently negotiated salary package. of the then recently negotiated salary package.

Several additional forecasts were made to determine their sensitivity to different expenditure growth assumptions. This was seen as particularly important given the judgmental nature of choosing rates and because of the magnitude, in percentage and dollar terms, of projected dollar growth.

Growth rates were varied for individual Objects of Expenditures while the rates for remaining objects were held constant at their original value. Figure 8 summarizes the results of these forecasts. While changes of one or two percentage points have little effect upon the overall growth rate of the campus budget, the absolute dollar differences are not insignificant.

Two additional forecasts were made, each of which involved changing

Figure 3. Average Annual Expenditure Growth Rates by Function and Object

Objects of Expenditure	Instr. & Dep'l Research	Org. Research	Ext. & Public Service	Org. Activities	Library	Stud. Services & Aid	Maint. and Operation	General Admin.	General Inst'l Services	Housing
Instructional Salaries	6.0									
Non-Instructional Salaries	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Temporary Service	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Supplies & Expense	6.0	6.0	6.7	4.6	5.0	5.0	5.6	6.5	5.1	5.6
Utilities							15.0			15.0
Equipment	5.5	5.5	1.6	5.5	5.5	5.5	5.5	5.5	5.5	5.5
Library Requisitions					15.0					
Student Aid						6.0				

(All Figures Represent Assumed Percentage Increases)

Figure 4. Expenditure Forecast Summary by Function, 1976-77 (Baseline) through 1981-82*

Function	1976-77 in '000 Base Year	Average Annual Price Increase	Projected Expenditures in '000 1977-78	1978-79	1979-80	1980-81	1981-82
Instruction & Departmental Research	21,082	5.9%	22,956	24,314	25,740	27,271	28,883
Organized Research	663	5.9%	595	632	669	708	749
Extension & Public Service	122	5.8%	129	137	144	153	162
Organized Activities	1,414	5.7%	1,493	1,578	1,663	1,757	1,854
Library	2,843	9.0%	3,087	3,360	3,660	3,986	4,372
Student Services & Aid	2,362	5.8%	2,498	2,643	2,796	2,960	3,130
Maintenance & Operations	5,584	83.%	6,034	6,528	7,073	7,674	8,337
General Administration	1,931	5.8%	2,043	2,161	2,287	2,420	2,561
General Institutional Services	3,699	5.5%	3,901	4,115	4,339	4,577	4,829
Housing	3,472	9.3%	3,794	4,128	4,513	4,941	5,419
GRAND TOTAL	43,672	6.7%	46,523	49,693	52,883	56,457	60,293

*This table summarizes the expenditure levels in future years which are necessary to maintain 1976-77 levels of programmatic activity.

Figure 5. Expenditure Summary by Object of Expenditure, 1976-77 (Baseline) through 1981-82*

Object of Expenditure	1976-77 in '000 Base Year	Average Annual Price Increase	1977-78	Projected Expenditures in '000 1978-79	1979-80	1980-81	1981-82
Salaries and Wages							
Instructional	15,632	6.0%	16,570	17,564	18,618	19,735	20,919
Non-Instructional	17,729	6.0%	18,793	19,922	21,118	22,382	23,725
Temporary Service	1,386	2.0%	1,393	1,420	1,448	1,480	1,508
Supplies and Expense	4,470	5.7%	4,721	4,989	5,271	5,570	5,884
Utilities	2,602	15.0%	2,878	3,306	3,805	4,376	5,032
Equipment	706	5.5%	744	786	829	875	922
Library Acquisitions	903	15.0%	1,038	1,194	1,373	1,579	1,816
Student Aid	364	6.0%	386	409	434	460	487
GRAND TOTAL	43,672	6.7%	46,523	49,593	52,893	56,467	60,293

Note: This table summarizes the expenditure levels in future years which are necessary to maintain 1976-77 levels of programmatic activity.

Figure 6. Projected Funding Deficits by Function, 1977-78 through 1981-82

Function	Assumed Rate of Revenue Growth*	Projected Funding Deficits in 000				
		1977-78	1978-79	1979-80	1980-81	1981-82
Instruction and Departmental Research	3.2%	680	1,234	1,830	2,682	3,466
Organized Research	5.7%	1	3	6	8	10
Extension and Public Service	5.3%	1	2	3	4	4
Organized Activities	6.5%	4	7	9	14	17
Library	4.3%	126	272	443	641	869
Student Services and Aid	6.1%	18	38	59	83	109
Maintenance and Operation	4.4%	214	482	746	1,072	1,447
General Administration	5.7%	3	6	13	18	24
General Institutional Services	3.8%	65	135	207	288	371
Housing	4.3%	169	362	560	850	1,152
GRAND TOTAL	3.9%	1,191	2,523	4,004	5,661	7,497

Note: Assumes (1) annual average revenue increase of two percent for all non-salary items, and (2) salary increases throughout the five-year period which reflect those granted in the 1977 contract negotiations.

Figure 7. Projected Funding Deficits by Object of Expenditure, 1977-78 through 1981-82

Object of Expenditure	Assumed Rate of Revenue Growth*	1977-78	Projected Funding Deficits in 000 1978-79	1979-80	1980-81	1981-82
Salaries and Wages						
Instructional	2.5%	547	1,141	1,784	2,480	3,233
Non-Instructional	6.1%	---	---	---	---	---
Temporary Service	2.0%	---	---	---	---	---
Supplies and Expense	2.0%	162	336	527	733	949
Utilities	2.0%	320	706	1,150	1,668	2,269
Equipment	2.0%	24	53	80	112	142
Library Acquisitions	2.0%	117	255	415	602	819
Student Aid	2.0%	15	30	46	66	85
GRAND TOTAL	3.9%	1,191	2,523	4,004	5,661	7,497

Note: Assumes (1) annual average revenue increase of two percent for all non-salary items, and (2) salary increases throughout the five-year period which reflect those granted in the 1977 contract negotiations.

Figure 8. Summary Results of Sensitivity Analyses

Object of Expenditure	Price Trend Assumed	Change From Initial Forecast	Resulting Growth Rate of Campus Budget	Change From Initial Rate	Resulting Campus Budget in 1981-82 (000 omitted)	Change From Initial Forecast for 1981-82 (000 omitted)
Instructional Salaries	6.0	-	6.66	-	60,293	-
	5.0	-1.0	6.32	-.34	59,325	- 968
	4.0	-2.0	5.98	-.68	58,393	-1900
	7.0	+1.0	7.02	+.36	61,209	+1008
Utilities	15.0	-	6.66	-	60,293	-
	10.0	-5.0	6.31	-.35	59,291	-1002
	20.0	+5.0	7.08	+.42	61,487	+1194
Supplies and Expenses	5.7	-	6.66	-	60,293	-
	3.7	-2.0	6.47	-.19	59,757	- 536
	4.7	-1.0	6.57	-.09	60,021	- 272
	6.7	+1.0	6.76	+.10	60,577	+ 284
	7.7	+2.0	6.87	+.21	60,872	+ 289
Library Acquisitions	15.0	-	6.66	-	60,293	-
	10.0	-5.0	6.53	-.13	59,931	- 362
	12.5	-2.5	6.60	-.06	60,104	- 189
	20.0	+5.0	6.81	+.15	60,724	+ 431
Equipment	5.5	-	6.66	-	60,293	-
	3.5	-2.0	6.63	.03	60,210	- 83
	4.5	-1.0	6.65	.01	60,250	- 43
	6.5	+1.0	6.66	.02	60,338	+ 45
	7.5	+2.0	6.70	.04	60,385	+ 02
Student Aid	6.0	-	6.66	-	60,293	-
	2.0	-4.0	6.63	.03	60,208	- 85

the growth rates of all Objects of Expenditure. One forecast ("optimistic") reduced the expenditure growth rates from what they had been in the initial forecast. The other ("pessimistic") raised the rates. The resulting campus growth rates (Figure 9) in each case changed by 20%, while the resultant dollar change was only about 7%.

These data are presented graphically in Figure 10 which portrays the growth over five years of the university budget for each of five expenditure assumptions. Even at a low 4% growth per annum, the budget for fiscal year 1981-82 would be about 20% greater than the 1976-77 budget. Growth of 7% per annum, on the other hand, would result in nearly a 40% increase. Alternatively, a one percentage point change in the rate of growth is equivalent, in dollar term, to a change of approximately $2.8 million in the fifth year of the forecast.

From our preliminary review of these additional forecasts we can draw two observations. First, it is clear that different expenditure rates have little impact on the magnitude of the problem identified in the initial forecast – significant increases in support are needed whether we are talking of price increases of 5%, 6%, or 7%. These increases range from 29% ($13 million) to 40% ($19 million) over the 1976-77 budget.

Even if price trends were to be lower than assumed, the rates for Objects of Expenditure and Functions which constitute a small percentage of the campus budget would individually have little effect on the rate of the overall budget growth. Obviously, this rate would decrease only if the rate(s) for significant items in the budget decreased. But, for example, even if instructional salaries (27% of the campus budget) needed to grow by only 3% per annum to keep pace with inflation (down from our assumption of 6%), this would only reduce the rate of campus growth by 1% per annum and the 1981-82 budget by 5%.

At the Function and Object level, however, the dollar changes resulting from varying rates are significant. For instance, a five percentage point drop in the price trend assumption for the purchase of library materials has little effect at the campus level, but reduces the fifth-year deficit in acquisitions by almost one-half.

Taking another example, a drop of five percentage points in the price trend for utilities is equivalent to a 20% reduction in expenditures, or $1 million. Thus, rate assumptions do make a significant difference at the Function and Object level and must receive further attention.

Before discussing the impact, problems, and conclusions to be drawn from our experience, it should be noted that we have completed only the first of several stages of development. This first stage focused on the development of a simple forecast model and the examination of the impact of inflation upon the budget. Subsequent stages should focus on

Figure 9. Assumed Price Trends and Summary Results for An Optimistic, Initial, and Pessimistic Forecast

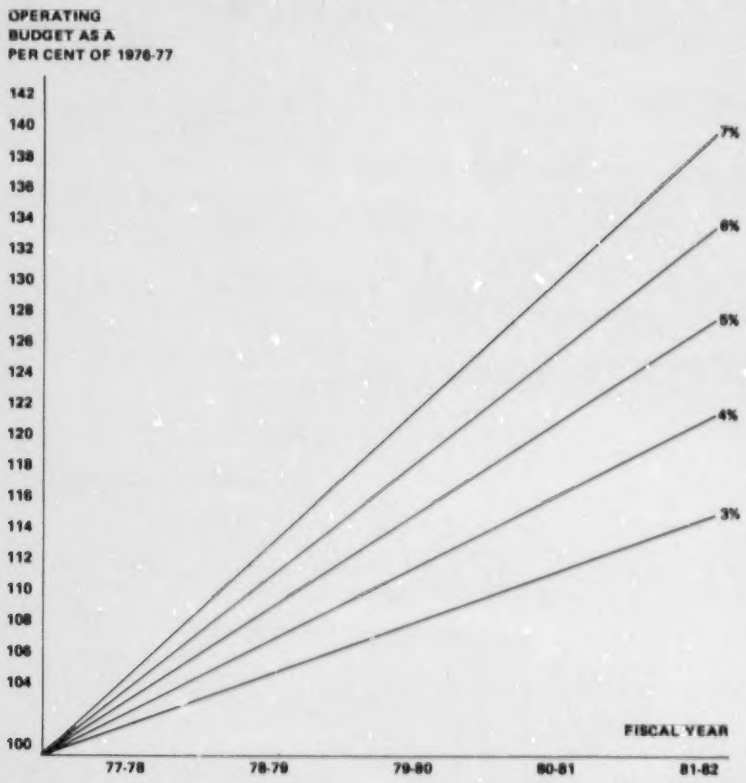
Object of Expenditure	Optimistic Price Trends	Initial Price Trends	Pessimistic Price Trends
Faculty Services	5.0%	6.0%	7.0%
Non-Instructional Salaries	5.0	6.0	7.0
Temporary Service	3.0	2.0	4.0
Supplies & Expense (Composite)	4.7)	5.7)	(6.7)
Instruction & Dept'l Research	7.0	8.0	9.0
Organized Research	5.0	6.0	7.0
Extension & Public Service	4.7	5.7	6.7
Organized Activities	3.5	4.5	5.5
Library	4.0	5.0	6.0
Student Services & Aid	4.0	5.0	6.0
Maintenance & Operation	4.6	5.6	6.6
General Administration	4.5	5.5	6.5
General Institutional Svc.	4.1	5.1	6.1
Housing	4.8	5.8	6.8
Utilities	10.8	15.0	20.0
Equipment	4.5	5.5	6.0
Library Acquisitions	10.0	15.0	20.0
Student Aid	3.0	6.0	6.0
Internal Rate of Inflation	5.33	6.66	8.12
Forecast Budget in FY 1981-82	$56,620	$60,293	$64,529

physical variables (e.g., enrollments, faculty size) and their relationship to financial variables in order to fully address trade-offs and identify significant planning issues. For a variety of reasons, primarily resource limitations, we have not yet moved to the subsequent stages which would involve implementation of a TRADES-type model. It is our intention to submit a recommendation to the president on what work, if any, should continue.

IMPACT ON MANAGEMENT

The results of the initial forecast were presented in summary form to the president and vice presidents in the Spring of 1977. Given the budget cutbacks which had been incurred, it came as no surprise that the campus would be facing financial problems in the future. What did surprise the top administrative officers was the projected magnitude of the problem. The severity of the "bottom line" led to considerable discussion of the assumptions underlying the calculations, the meaning of certain variables, and the options open to the campus for solving the problem. Through this process,

Figure 10. Budget Growth Under Different Expenditure Price Rate Assumptions, 1976-77 to 1981-82



the president and vice presidents became familiar with the workings of the model and hence gained greater insights into the basic financial structure of the campus. The process of understanding was greatly facilitated by the high level of aggregation used in the model; thus the focus was on the "big picture" and was not impeded by unnecessary details.

Management decided on a four-pronged approach for action:

- The results of the model would be presented to the two external bodies which exercised the greatest amount of influence on the

state appropriation to the campus: SUNY-Central and the State Division of Budget.

- The results of the model would be conveyed to campus officials responsible for private fund-raising efforts; these officials could then use the data to inform alumni and other friends of the university of the real financial problems facing the campus.
- Further studies focusing on possible reallocation strategies were to be prepared on campus.
- Further studies focusing on potential gains in efficiency were to be prepared on campus.

The first strategy, presentation of the results to external authorities, began at the campus' preliminary budget hearing with SUNY-Central in the Summer of 1977. This was a less-than-satisfactory experience. One official of the SUNY system commented, for example, that "all models like this are guesswork." It was clear to the campus officials in attendance that little attention would be given to it in the budget planning process at SUNY-Central.

There are a myriad of possible explanations for this experience, including a poorly planned presentation strategy by the campus. The most viable hypothesis, however, is that SUNY-Central officials follow a highly politicized strategy in making resource allocation decisions to the 64 campuses under their control, and the model as currently constructed may be incongruent with such a strategy. This is not to say that a political strategy is inappropriate at the SUNY system level, where the concerns of various officials in the executive and legislative branches of government must be recognized; rather, it is to say that such a strategy may or may not be congruent with the real needs of the various campuses.

The model has not yet been presented to Division of Budget officials primarily because of the less-than-encouraging experience with SUNY-Central. However, plans are currently being formulated to make a presentation at an appropriate time.

During 1978 the results of the model have been used in the private fund-raising efforts of the campus, only informally. That is, the projected funding deficits have been communicated in "dinner-table conversations," but not in any systematic, formal presentation to alumni or friends of the university. With greater emphasis being placed on the need to increase non-state funding, as indicated by the establishment and filling of the new position of Director of Resource Development, the model is destined for a larger role.

Finally, the campus has increased its emphasis on reallocation of funds and cost cutting devices. This emphasis existed prior to the results of the model being available, but the model provided significant reinforce-

ment for this approach to financial management. The model results also provide some direction for managerial attention by identifying areas where the greatest deficits are likely to occur.

PROBLEMS OF IMPLEMENTATION

There were three types of problems encountered during implementation of the model. The first type was conceptual. Much time was spent early in the project attempting to understand the constraints of the SUNY budgeting system as they related to private institutions and particularly to the financial planning concepts spelled out by Massy and Hopkins. It was clear, for example, that the emphasis placed on endowment at Stanford was not appropriate to Albany's financial profile. This and other adjustments were made to reflect more accurately our own particular financial structure.

The second type of implementation problem was technical. SUNY-Albany has no computerized financial system, even for transactional purposes.[6] This meant that a large number of manual calculations were required to develop inputs for the model, a problem which was exacerbated by the lack of systematic archival data in proper formats. One graduate assistant logged approximately 150 hours in accomplishing this task before the model was programmed. A lack of historical data is a significant impediment to this kind of effort, regardless of whether or not one intends to utilize a computer-based model. Although these technical problems did not prove to be overly complex, they did require a significant amount of routine labor before the forecasting model could be implemented.

The last type of implementation problem might best be labeled as attitudinal/behavioral. Some initial lack of interest in the project was alleviated to a great extent by the leadership of President Fields. However, as the project moved into the technical stages of model-building, the president, naturally, was not involved for weeks at a time. The lack of visibility of the president, combined with the fact that the project did not directly involve several members of the financial management team, may have contributed to a general lack of enthusiasm. Another possible cause of the lack of enthusiasm was lack of clarity about the potential benefits of a long-range projection model in an environment which has always focused on year-to-year budgeting. For example, an oft-repeated concern was that the model would be a waste of time until and unless external financial authorities adopted a multi-year planning horizon. There is obviously a great deal of education to be accomplished both externally and internally if the model is ever to become an integral part of the financial planning process.

CONCLUSIONS

Several conclusions can be drawn from the SUNY-Albany experience. Hopefully, they will be of use to other institutions which may be contemplating the adoption of similar techniques:

- *The forecasting model provides a useful tool for identifying both the nature and magnitude of potential financial problems.* As such, it can provide a stimulus for action well in advance of the problems, although the number of options available to public institutions may be fewer than in the private sector.
- *It is of little use to identify potential problems if no mechanisms are developed to address those problems in a systematic way.* SUNY-Albany did not achieve the desired follow-through in those areas where the impact could have been the greatest. As indicated earlier, there is really no individual who must shoulder the blame for this lack of follow-through; rather it was a failure on the part of the institution to encourage a systematic address of the problems internally.
- *It is critical to involve all major actors in the project from the outset.* Especially when the model is being initiated by persons outside the offices responsible for financial management, much consultation is required and should be combined with a top-down initiative from the presidential level.
- *The basic model is of real value at the presidential and vice presidential level because of the level of aggregation of data.* At the same time, it is of little use to offices below this level. The model is, by its nature, a planning tool more than a budgeting tool.[7] As was discussed earlier, the model results were used by the president and vice presidents at SUNY-Albany to develop a strategy to influence external budget authorities in the state government and to stimulate private giving.
- *The value of a long-range (more than one-year) forecast is greatly conditioned by the time perspectives employed by those state officials who determine the campus budget.* As has been seen, the time horizon for budget planning in New York State is primarily one year. This relatively short-range view, in turn, delimits the time horizons of financial managers at the individual campuses within SUNY.
- *The model also provides a useful tool for evaluating the effects of alternative financial policies,* whether prepared on campus or by external bodies. In this sense, the model can provide a vehicle for ad hoc analyses that may or may not be directly related to the campus planning process.

In summary, the model has produced significant benefits for SUNY-Albany, but fewer than one would hope. It has led to multi-year thinking in several parts of the institution for the first time. It forced decision-makers to think more broadly about the financial environment of the institution. It produced a set of price indicators that can be used in the allocation process. It clearly revealed the potential financial problems facing the campus and stimulated greater efforts in private fund-raising. At the same time, it did *not* result in an appreciation of campus needs by state officials beyond that which already existed. Strategies are currently being formulated to communicate better with such officials and to use the model as appropriate for discussion of program needs and financial implications.

Footnotes

1. These overlays have been well documented in a recent study conducted by the Vice President for Finance and Business on the Albany campus. The study revealed, for example, an average time lapse of 15 weeks between the initiation of a purchase order for equipment and its final approval by the last agency in the chain.
2. This point will become an important one in a later section of this paper which focuses on the external benefits derived from applying the financial model on the Albany campus.
3. The SUNY system has had in effect, since 1970, a policy that all graudate programs are to be reviewed by outside consultants at least once every five years. The process recently has been extended to undergraduate programs as well.
4. As will be discussed in the "Problems of Implementation" section, it was a mistake to not include more individuals from the financial area on the initial project team.
5. The detailed study of varying price increases has proven to be valuable apart from its use in model development. It has been used, for example, to justify increased Supplies and Expense allocations to schools and departments that are faced with disproportionate price increases.
6. A large-scale project is currently underway to remedy this deficiency. The first phase of the project, entitled Financial Accounting Management Information Systems (FAMiS), is scheduled for completion in January, 1979. All phases should be completed by late 1980.
7. Of course this phenomenon itself may partially account for the lack of enthusiasm on the part of some middle managers.

III. APPLICATIONS OF A GENERALIZED FINANCIAL PLANNING MODEL

10

EFPM: Generalizing the Stanford TRADES Model

Daniel A. Updegrove

INTRODUCTION

The financial crisis in higher education continues to be a pervasive problem. Although controversy has surrounded both the estimates of the number of institutions in financial difficulty and the alternative remedies for this difficulty, there is a broad consensus that colleges and universities have seen expenses grow faster than income in the last decade, and that demographic trends and taxpayer attitudes will aggravate the problem in the future. One response to the financial crisis has been the development

Acknowledgements. I wish to acknowledge the extensive contribution of my EDUCOM colleague Alexander M. Jones in the design and execution of EFPM. The project has also benefited greatly from the suggestions of Frederick Rogers of Carnegie-Mellon University; John Rudan, Wade Schuette, and Douglas Van Houweling of Cornell University; Greg Mills, Albert Nichols, Joe B. Wyatt, and Sally Zeckhauser of Harvard University; Stephen Dresch of the Institute for Demographic and Economic Studies; James Poage and Margie Wainio of Princeton University; Nathan Dickmeyer and David Hopkins of Stanford University; Janet Ackerman, Greydon Freeman, and John Goldin of Yale University; and Dan Bernard, James Emery, Paul Heller, Alexander Jones, Carolyn Landis, Elizabeth Little, Beverly O'Neil and Ronald Segal of EDUCOM. Administrative and secretarial support have been provided by Jan Bloor, Donna Davis, Rod Mebane, Lynn Ann Merrill, and Helene Schwartz.

and use of computerized financial planning models, which are mathematical representations of the factors underlying income and expense totals.

Although a survey of higher education planning models is beyond the scope of this article (Gray, 1977), several generalizations can be made. Some models, like SEARCH and HELP/PLANTRAN, are simple to understand and operate, but are not sufficiently powerful or flexible (Kean and Daniel 1970 and Midwest Research Institute, 1972). Models like RRPM and CAMPUS have more powerful objectives, but are expensive, hard to understand, and difficult to supply with the extensive data they require (Clark, 1973 and Judy, 1969). A third class, which is more properly labeled modeling languages or modeling systems, offers both power and flexibility but at a price that few institutions can afford (Association of Time-Sharing Users, 1978). As a result, planning models have not been widely and successfully used in higher education.

BUILDING ON THE STANFORD MODELING EXPERIENCE

As described in the foregoing papers, the extensive modeling of Massy, Hopkins, and Dickmeyer at Stanford stands out. A set of aggregate models were constructed that were simple, robust, conversational, and relevant to the financial problems at hand. Both the product and the Stanford modeling process were significantly different from most other prior modeling efforts. In common practice, a university administrator will assign an outside consultant to produce a planning model with little guidance or interest from the policy maker. At Stanford, however, the key decision makers guided model development, testing, and operation.

The EDUCOM/Lilly feasibility study of generalizing the Stanford model focused on both the modeling process and on the Stanford model. Policymakers from each participating institution selected one or more of the Stanford models for adaptation of their institution. Although each institution found its new model to be useful, not only as an analytical tool but also as a communications medium, significant reprogramming was required to exise the Stanford-specific content. (See previous chapters.)

These preliminary results of the study led project directors Wyatt and Massy to allocate a portion of the remaining project funds to build a prototype generalized model. In order to capture the essence of the Stanford approach, the prototype model had to be an interactive, medium-range, forecasting and tradeoff model focusing on aggregate planning variables. To be generalizable, the model had to operate without constraining the user's choice of variables, relationships, and output formats. Furthermore, the project directors sought to develop a generalized model that required little or no reprogramming to adapt to new institutions. They asked EDUCOM to begin to design such a model.

DESIGNING THE GENERALIZED MODEL

The first EDUCOM design proposal called for a conversational model that would incorporate forecasting and tradeoff features drawn from the Stanford TRADES model. Under this alternative, institutional contents would be specified by the user in FORTRAN subroutines. The generalized model was to be designed for non-programmers, but, since the model would probably be used on an institution's own computer, a programmer would have to be found at each installation who was familiar with the local computer system. A second design proposal was founded on the premise that models dependent on local computers and local programmers are inherently less useful to policymakers. The time and cost required to convert computer-dependent models to a new institution are nearly always prohibitive, and the hiring of a new programmer at the new site also raises costs. Finally, no matter how much good documentation was produced, the programmer responsible for institution-dependent subroutines would almost certainly produce a model perceived as a "black box" by policymakers.

The second design proposal, chosen for the EDUCOM/Lilly project, was based on three principles: 1) most, if not all, of the institutional information should be included in a set of self-documenting data files comprehensible to the non-programmer; 2) the modeling program should operate by a series of questions and answers, with sufficient nontechnical explanations to be operated by someone other than the creator of the data files; 3) the computer-based model should be available over a nationwide telecommunications network, so that many users could dial into the computer system, but only one copy of the generalized model would have to be maintained.

To allow for later transport, project directors agreed that the model would be built and tested on one central computer but all programming would be done in FORTRAN, the most common language.

THE EDUCOM MODEL

The EDUCOM Financial Planning Model (EFPM), as it is now called, is operational on the IBM 370/168 computer at Cornell University in Ithaca, New York. EFPM runs under the VM-CMS operating system, which allows multi-terminal access to one program while providing secure data storage for each user. Because the Cornell computer is a host for both TYMNET and Telenet telecommunications networks with local dial-in ports in more than 200 cities in the U.S.A., the model is easily available to users.

During initial development, EFPM was tested by modelers in four universities. In fact, working models of Carnegie-Mellon University and Yale

University implemented under EFPM are described in this volume. The fact that we can present two working models only seven months after the start of the Lilly/EDUCOM project is a tribute to the power of network delivery. It is inconceivable that another kind of model could have been used on the basis of update tapes transmitted to the user campuses. Our confidence in the applicability of the model to college and university financial planning has been greatly increased as institutions have literally helped us develop the generalized model.

USER DATA FILES AND THE EFPM VALUE MATRIX

EFPM users start with a blank matrix of 560 rows by 10 time periods each usually set at 1 year (see Figure 1, page 202). The contents of the matrix will be determined by user defined variables and relationships contained in a set of six on-line data files. The six on-line data files are:

1. Data descriptions
2. Budget functions
3. Growth functions
4. Report formats
5. Discontinuous or step functions
6. Feasibility constraints

The first file contains identifying numbers and descriptions of all variables. Initially this file contains year-one values (or instructions for calculating those values) for all planning variables. Year one values of variables will fill the first column of the EFPM matrix as shown in Figure 2. A sample first file containing year-one values is shown in Table 1. Column 1 contains the identification (ID) number of the variable; 2, the abbreviation; 3, the base-year value, if exogenous[1]; 4, the ID of another variable to be used as a price index, if any; 5, the number of decimal places to be printed in reports; 6, the full name to be printed in reports; and 7, a space for user notes.

Variables described in the sample first file illustrate one of the strengths of EFPM: the ability to forecast financial relationships in either a "real" or "nominal" mode. Two price variables, or indexes, are defined in this example (ID numbers 1 and 2) that generate nominal growth from year to year in the variables assigned to them. Additional real growth rates are also defined (ID numbers 61, 68, and 76 in this example). When forecasting in the nominal mode, EFPM calculates growth based on both price indexes and real growth rates. When the user selects to forecast in the real mode, EFPM ignores price indexes and calculates growth using only real growth rates.

[1] Exogenous variables are determined by the user. Endogenous variables are calculated within the model according to relationships specified by the user.

Exogenous variables (e.g. 1, 2, 11, 13, etc. in sample) are combined in ways specified by the user to yield endogenous variables that fill the column of year one values in the matrix completely (Figure 3). Referring back to Table 1, note that endogenous variables 34 (total number of faculty), 113 (tuition income), 182 (surplus or deficit), and 191 (student-faculty ratio) are not given initial values since they are calculated from other variables. The user specifies the calculations to be performed in a second file although the relationships may also appear in comments in the first file as shown in Table 1.

TABLE 1. Sample First File Containing Variable Descriptions

1	INFLATN	0.065		3	INFLATION RATE / CPI	COMMENTS
2	UTLPRICE	0.150		3	UTILITY PRICE INCREASE	
11	TUITION	2.5	1	1	TUITION RATE (IN THOUSANDS)	
13	FRINGBEN	0.1		2	FRINGE BENEFIT RATE	
16	ENDOWPAY	0.0		3	ENDOWMENT PAYOUT RATE	
18	FACSAL	17.2	1		AVERAGE FACULTY SALARY	
31	FTE-ENRL	1800.			FTE ENROLLMENT	
32	NUMFACTN	100.			NUMBER FTE FACULTY-TENURED	
33	NUMFACUN	50.			NUMBER FTE FACULTY-UNTENURED	
34	TOTFAC				NUMBER OF FACULTY TOTAL	32 + 33
61	QTUITION	0.01		2	REAL GROWTH TUITION+FEES	11
68	QFACSAL	0.0		2	REAL GROWTH-FACULTY SAL	18
76	QFTEENRL	0.0		2	GROWTH OF FTE ENROLLMENT	31
113	TUITINC				TUITION INCOME	11 * 31
182	SURP-DEF				SURPLUS (DEFICIT)	181-180
191	STU/FAC			1	STUDENT / FACULTY RATIO	31 / 34

The second file must contain specifications for the calculations, known in EFPM as budget functions. Table 2 shows a representative set of budget functions from the sample case. A reverse notation is used, so that the first line of the table is interpreted as follows: variable 34 is the sum of variable 32 and variable 33. The second line is interpreted, variable 113 is the product of variable 11 and variable 31. Although several special functions are also available, most of the calculations needed for financial modeling can be defined by the four arithmetic functions of addition, subtraction, multiplication, and division.

For the second and subsequent time periods, EFPM must be instructed how to determine the value of the exogenous variables (Figure 4). If

TABLE 2. The Second File: Sample specifications for calculations

34 + 32 33	TOTAL NUMBER OF FACULTY
113 * 11 31	TUITION INCOME
182 - 181 180	DEFICIT (SURPLUS)
191 / 31 34	STUDENT-FACULTY RATIO

Figure 1. Blank EFPM matrix

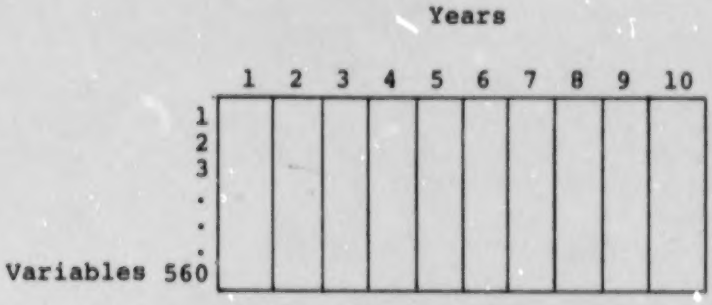


Figure 2. EFPM matrix with year-one values

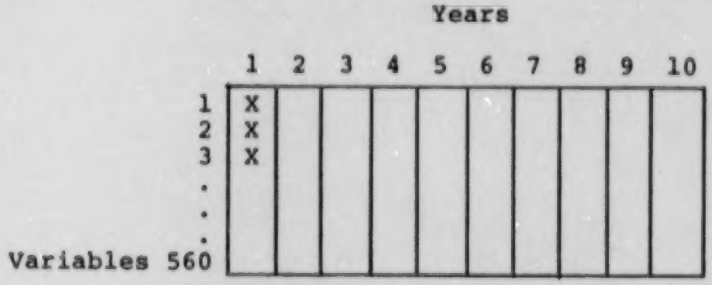


Figure 3. EFPM matrix with year one values of endogenous variables calculated

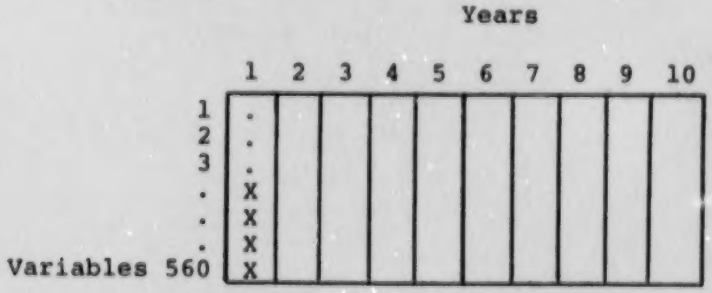


Figure 4. Filling in year-two values for exogenous variable in the EFPM matrix

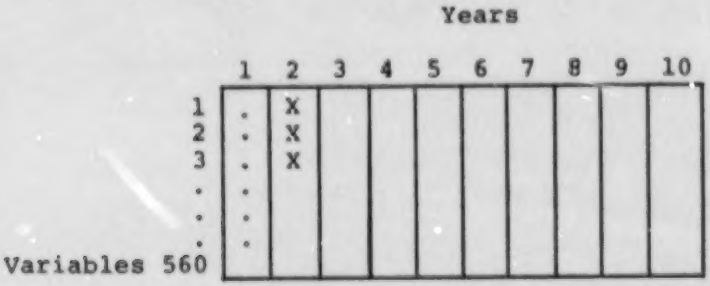


Figure 5. Filling in year-two values for endogenous variables in the EFPM matrix

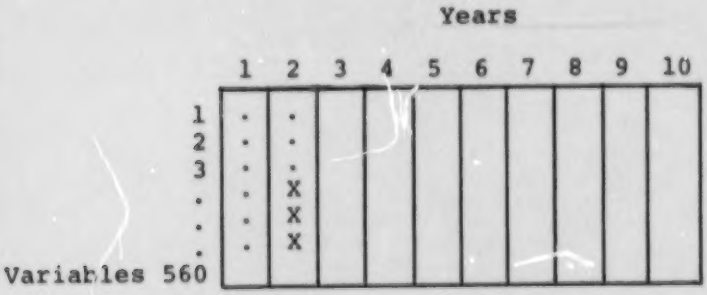


Figure 6. Filling in step increments or replacements in the EFPM matrix

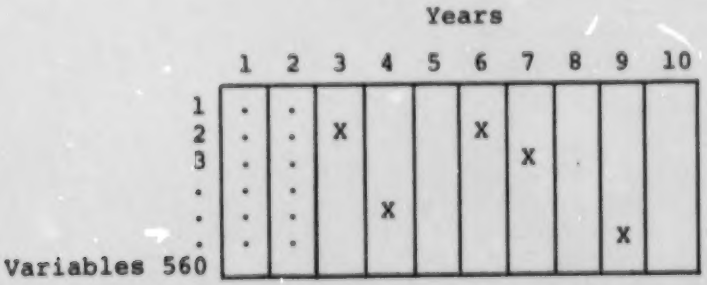


Figure 7. The EFPM matrix completed

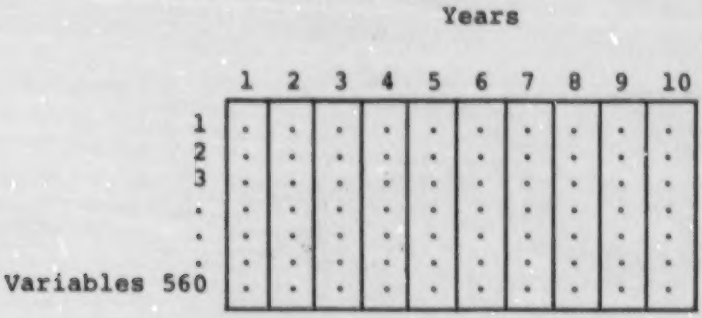
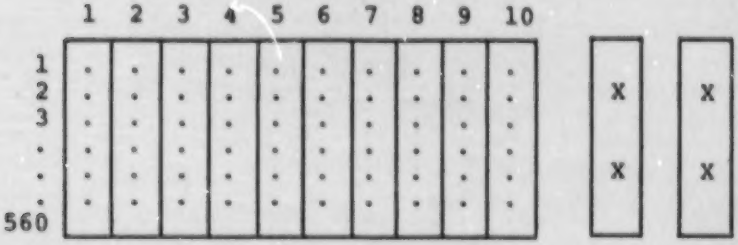


Figure 8. Setting Constraints against which EFPM will match forecasts



not instructed otherwise, EFPM assumes that the value is unchanged, and simply copies the previous values. For values that do change, the user must decide whether to have them change at nominal growth rates, real growth rates, or both and whether to have the growth rates continue over the entire time period or change in a "step" fashion. Real growth rates for each variable are determined by one or more growth rates as specified in a third file. If nominal growth is selected, the user also assigns a price index to each exogenous variable that is described in the first file.

Table 3 shows growth functions, called G functions, from the test case. In the first line of this table, EFPM interprets as follows if nominal growth (real growth plus inflation of prices) is desired: multiply the previous value for variable 11 (TUITION) by the sum of growth rate variable 61 (GTUITION) and the price index (inflation) for tuition, variable 1 (INFLATN). Referring again to the sample data in Table 1, the calculation

TABLE 3. Sample EFPM Growth Functions

11 G 61	TUITION
18 G 68	FACULTY SALARY
31 G 76	FTE ENROLLMENT

of nominal growth for tuition is:

$$2.5 \times (1.0 + .065 + .01)$$

A multiplicative instead of an additive growth function (named H instead of G) is also available. Thus if given the function 11 H 61, EFPM would calculate 2.5 x (1.01 x 1.065) to determine growth of tuition variable number 11 from time period 1 to time period 2. Growth functions apply directly only to exogenous variables. Growth for endogenous variables is derived indirectly, using the new values for exogenous variables.

To calculate new values for endogenous variables for the second and subsequent time periods, EFPM begins with the new values of exogenous variables regardless of whether they have been grown in real or nominal mode. EFPM then applies specifications for calculating endogenous variables, called budget functions and stored in file two, to the year-two values of exogenous variables. Refer back to Table 2 for budget functions from the sample case. EFPM records the results of the budget function calculations for the second time period in the second column of the matrix as specified in Figure 5.

If the user is satisfied that the growth rates and budget functions used to forecast from time period one to time period two will continue to persist throughout the ten periods, the matrix may be completed by the methods just described. For each time increment, exogenous variables are projected or grown by specified growth functions stored in the third and fourth files; and, endogenous variables are calculated according to the budget functions stored in the second file.

If the user wishes to change a growth rate or a budget function in the forecast at specified future times, EFPM can comply. Such changes are called steps, and they are inserted into the forecast in time periods specified by the user (Figure 6). Steps can be specified as either increments (to be added to the value otherwise determined) or replacements. Discontinuous or step changes in growth are specified in file 5.

In summary, EFPM forecasts from one time period to the next by first calculating new values for exogenous variables (using growth functions) and then calculating new values for endogenous variables (using budget functions). Discontinuous or step increments for growth or budget

functions may be inserted by the user at specified future dates. Using all of these specifications, EFPM can fill the entire matrix for time periods 1 through 10 as illustrated in Figure 7. The matrix can be filled in real mode where only real growth rates are used for calculations; or the matrix can be filled in nominal mode where both real growth and price index are applied. The user may choose real or nominal mode at the beginning of each forecast.

Once the matrix of values is complete, selected rows and columns can be printed on the terminal, again under user control. Another file (number four) specifies the subsets of variables to be included together with report numbers and title (Table 4). Up to 30 reports can be specified, each using up to 45 variables. A final (and optional) data file accommodates the feasibility constraints. Without constraint, EFPM merely projects future forecasts. With constraints, given as a minimum or maximum for any or all variables, EFPM flags individual forecasts and performs feasibility matches and tradeoffs by varying the exogenous variables in attempt to find the boundary between feasibility and infeasibility. The setting of constraints is shown graphically in Figure 8. Reports that can be produced to illustrate feasibility and infeasibility under constraints are shown in the sample case in Tables 6 and 7 and are described in the following section.

RUNNING THE MODEL

Once the data files are created and stored on-line, EFPM can be run from a computer terminal by a user responding to a series of prompting

TABLE 4. Sample Report Specifications

```
01  PRIMARY PLANNING VARIABLES
01  01      1   2  16  21  61  62  68  69  70  76  78  80  81  83  91
01         93  96 999

03  FORECAST SUMMARY
03  03     11 142 180 181 182 195   0 191  31   0  55 999

04  DETAIL ON REVENUE
04        110 111 112 113 114 115 116 117 118 119 120 121 122 123 124
04        126 127 128 130 131 132 133 134 135 136 137 138 139 140 141

05  DETAIL ON EXPENDITURES
05        150 151 152 153 154 155 156 157 158 159 161 162 163 164 165
05        166 167 168 169 170 171 172 173 174 175 176 177 178 179 999

06  DETAIL ON ENDOWMENT
06         51  52  53  54  55   0  15  16  84 194 117 118 119 120 999

07  DETAIL ON STUDENT AID
07        189  11  12  22   0 175 132 133 134 190   0  61  21 999
```

questions. In response to "ENTER OPTION:," a user might type, "PPV, BUDGET, FORECAST, TRADEOFF, MISC, or END." If these valid answers were not known, a user entry of "?" would elicit the following EFPM response:

```
OPTIONS ARE:
PPV         TO MODIFY PRIMARY PLANNING VARIABLES
FORECAST    TO DISPLAY FORECASTS UP TO 10 YEARS
TRADEOFF    TO PERFORM TRADEOFFS
MISC        TO PERFORM MISC EDITING AND FILE MANAGEMENT
END         TO END EFPM
```

If the user then typed "FORECAST," followed by "BASE" in response to "ENTER BASE OR TRIAL," and followed by "5" in response to "ENTER END YEAR FOR FORECAST," output similar to that shown in Table 5 would be printed on the terminal. Using the PPV option, the user could then change the selected values of the primary planning variables and run a trial, "what if," forecast to be compared to the base forecast.

TABLE 5. Sample Five Year Forecast without Restraint

FORECAST SUMMARY (ALL DOLLAR VALUES ARE IN THOUSANDS)				11/05/78	
	1979	1980	1981	1982	1983
TOTAL REVENUES	8162.	8618.	9112.	9653.	10249.
TOTAL EXPENSES	8555.	9089.	9678.	10328.	11046.
SURPLUS (DEFICIT)	-393.	-471.	-565.	-674.	-797.
CUM. SURPLUS (DEFICIT)	-393.	-864.	-1429.	-2104.	-2901.
TUITION RATE	2.5	2.7	2.8	3.0	3.2
FTE ENROLLMENT	1800.	1800.	1800.	1800.	1800.
STUDENT/FACULTY RATIO	12.0	12.1	12.2	12.4	11
ENDOWMENT MKT VALUE	33279.	34444.	35649.	36897.	38188.

An option quite different from FORECAST is TRADEOFF in which the user requests EFPM to determine the combinations of PPV values that satisfy a set of user-defined feasibility conditions. In the one-way feasibility search, EFPM changes each PPV until the feasibility boundary is found, while holding all other PPV's constant. Table 6 shows the results of a two-year feasibility search for a fictitious college, in which the constraints are an operating surplus between zero and one-half million dollars by 1980 and a student-faculty ratio between 15 and 18. Thus, real tuition growth

TABLE 6. Sample EFPM One-way Feasibility Search

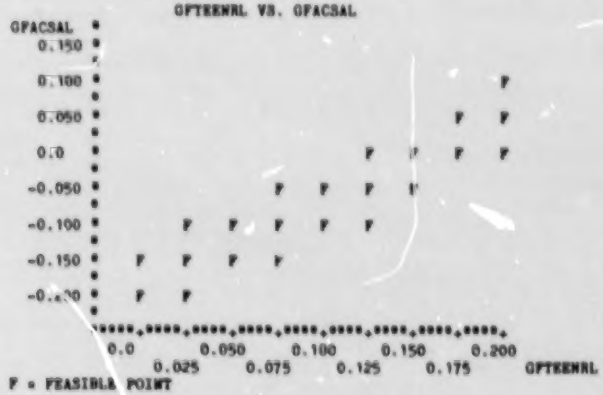
REQUIRED CHANGES IN PPV'S				
ID, NAME,	VALUE,	STATUS,	MIN,	MAX:
61 GTUITION	0.0	LO	0.15	0.23
68 GFACSAL	0.0	HI	-0.24	-0.12
76 GFTEENRL	0.0	LO	0.14	0.22
62 GNUMFAC	0.0	**	**	**

(GTUITION) must be between 15% and 23%, or faculty salary growth (GFACSAL) between -12% and -24%, or enrollment growth (GFTEENRL) between 14% and 22%. Asterisks in the last row of the figure indicate that the number of faculty (GNUMFAC) cannot be reduced sufficiently to balance the budget without violating the student-faculty ratio constraint.

Because an institution is not likely to change only one planning variable, EFPM also displays the results of a tradeoff between two PPV's changing simultaneously over user-specified ranges. Table 7 shows the results, in the same case, of varying enrollment growth (on the X-axis) and real faculty salary growth (on the Y-axis). The points labeled "F" are feasible, and the pattern and slope show the enrollment growth required to increase faculty salaries while balancing the budget.

These interactive display, modification, and analysis functions allow users to explore a wide range of policy options and contingency plans in a matter of minutes. Furthermore, the dialogue and help features enable almost any user to run the model and understand the results.

TABLE 7. Sample EFPM Two-way Trade-off Graph



COSTS

The costs for running EFPM range from $8 to $20 per terminal connect hour (including a network surcharge), plus approximately $5 per month for data storage. In addition, each user pays an annual subscription fee of $1000 for EDUCOM members or $1250 for nonmembers, and a one-time implementation fee of $1500 or $1750 respectively. The sub-

scription fee covers the costs of maintenance and documentation, and the implementation fee includes the cost of on-campus and remote consulting on the most appropriate and efficient use of the model. Because the fee schedule is set by EDUCOM to recover all project costs, these costs are subject to change.

USER'S GROUP

To complement the content-free structure of EFPM, EDUCOM is actively promoting a users group for interchange of data, submodels, and experiences. For instance, the Yale model borrows from Stanford (TRADES) submodels for term bill, income, and financial aid. Rather than imposing some submodels on all users, each college can select from optional submodels available in on-line files at Cornell University. Other advantages of network access include a real-time conversational capability for users logged on simultaneously, and an electronic mail system for leaving messages to be read. Through the users group, EFPM can be transformed from a content-free computer program to a channel for resource sharing and cooperative problem solving in higher education.

POSTSCRIPT

In the months since the August 27-29 modeling workshop, EFPM has been used to develop models at Boston College, Colgate University, Harvard University, Oberlin College, Purdue University, and the University of Virginia. At Butler University, Cornell University, Cuyahoga Community College, the University of Louisville, San Jose State, and Mills College, the model exists in various stages of model specification, testing, or construction. EFPM modeling applications at Harvard, Stanford, and Virginia have included models of university subunits such as buildings and grounds, the library, and the medical school. Other developments include the creation, by Alexander Jones of EDUCOM, of a 50-year tenure model to demonstrate the feasibility of using EFPM for non-financial planning applications. The first meeting of the users group was held on November 15 in Washington, D.C.

Finally, the Lilly Endowment has agreed to fund an 18-month project for additional development, documentation, and evaluation of EFPM. Program development will be an iteractive process of building data files, an option to segregate and reaggregate the subunits, and more graphic displays. Written documentation to be published includes a revised version of the users manual and summary descriptions to facilitate the exchange of data files among users. In addition, the project will evaluate several of the early uses of the model analyzing the type of institution, the

character of the modeling process, the place of the modeler in the decision-making structure, and the impact of modeling on the institution.

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11

Financial Modeling at Carnegie-Mellon University and the Role of EFPM

Frederick A. Rogers

BACKGROUND

Carnegie-Mellon University is a medium-size, research university located in Pittsburgh, Pennsylvania. During the 1970's CMU has experienced both growth and contraction in the operating budget (real dollars), enrollment and numbers of staff. The academic and financial measures shown in Figures 1-3 give the pattern and magnitude of these changes.

CMU has a balanced budget for 1978 and has operated in the black for six years. The university also has an accumulated deficit of over $3 million from the years 1969-1972 when expenses exceeded income. When Richard M. Cyert was appointed President in 1972, he increased income, applied stringent controls on expenditures, and reduced staff, primarily in the administrative and physical plant areas to achieve a balanced budget in one year.

The process of modifying a university the size of Carnegie-Mellon to live within a constant budget generated the need for a variety of models and analysis.[1] Both income and expense variables in the budget were constrained within narrow limits. The president and his staff carefully evalu-

Figure 1. Total Fall FTE Enrollment

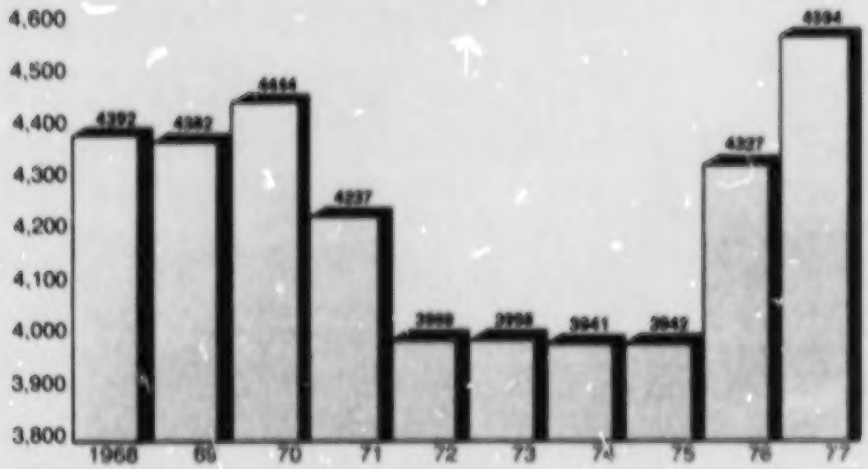


Figure 2. Full-time Employees

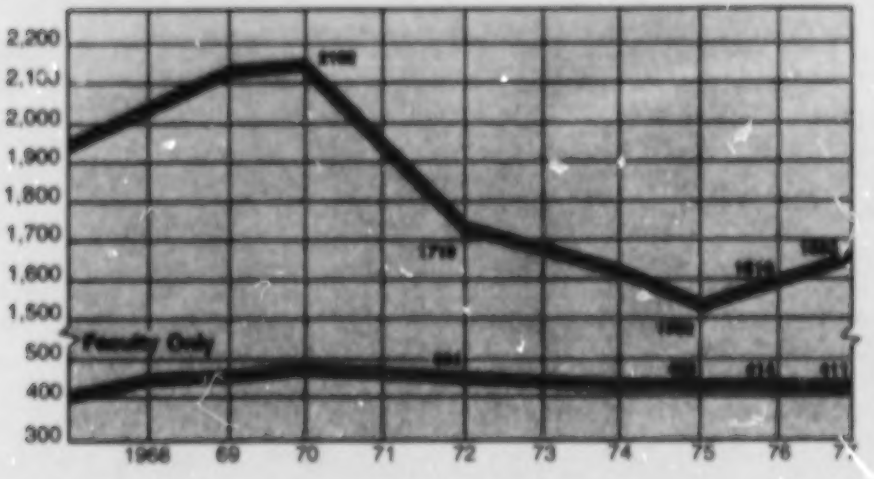
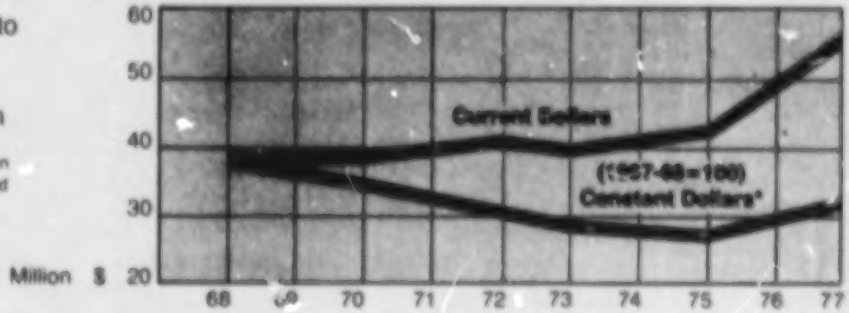


Figure 3. General Fund Operating Expenses

Constant dollars compared to current dollars

Ten Year Scale Comparison

*Determined by using th. Higher Education Price Index developed by D. Kent Halstead and reported in the Chronicle of Higher Education. September 6, 1977. Vol. XV. No. 1. p. 13.



Financial Modeling at Carnegie-Mellon University

ated the alternatives that were available and acted quickly to restore a balance. The president and the trustees were not prepared to wait several years to achieve a balanced budget. At the same time, the president implemented a number of measures designed to improve the long-run strength of the university. Cyert assigned high priority to increasing the number of applications from high quality students, improving the return from the university endowment, increasing the research volume and expanding the Carnegie-Mellon Institute of Research.[2] The president appointed a Committee on Scale to study alternative strategies that would enable the university to operate at an equilibrium. Every department on campus prepared a strategic plan that was critically reviewed by the president, vice presidents and deans as they revised the budget allocations to reallocate funds to the strategically important areas within the university.

For the first three years of the Cyert administration, the budget grew very slowly. Total expenditures of $40 million in 1971-72 increased to only $43.8 million in 1974-75. Salary increases were modest and staff and faculty were further reduced by attrition. During this period of contraction, the size of the student body remained virtually constant. There was only one tuition increase which came in the third year and which amounted to a 5% annual increase compounded over the three years. The market value of the endowment also remained relatively constant over this period.

By 1975 the budget was still balanced, but CMU had not yet reached an equilibrium with respect to budget growth rates. Income was not growing as fast as expenses, and further contraction or new income were the only ways to continue to balance the budget. The total full-time staff of 1,710 in 1971-72 had declined to 1,552 including a reduction of 36 faculty out of an initial total of 464.

FINANCIAL PROJECTION MODELS

In the spring of 1975, the Planning Office developed a simple endowment-tuition trade-off model[3] patterned on the work at Stanford on long-run financial equilibrium.[4] This model was discussed by the Tuition Committee that year as they debated the tuition increase for Fall 1976. One major conclusion supported by this model was that an annual tuition increase of at least 7% was essential under most conditions to enable the university to continue to balance its budget. The Tuition Committee recommended an increase of $200-$400 for 1976, and the president chose an increase of $200, an increase of about 7%.

At about the same time, CMU also developed a simple projection model for testing and demonstrating the financial equilibrium of the annual budgets presented to the trustees. This projection was based on discussions of such issues as expenses, the size of the student body, the tui-

tion rate and the endowment spending rate. The model and the projections were discussed with the president, vice president, provosts, the Budget Office, the Tuition Committee and the deans in the Spring of 1975, and a revised version was shown to the trustees in the Fall.

The projection model developed in 1975 has been updated each year in a similar fashion. These projections have consistently underestimated the actual results since then; both income and expenses have grown faster than anticipated. The freshman class in September 1975 was the largest in the school's history. The class which entered in September 1976 was again larger. In addition, sponsored research revenues have grown at rates of 10% per year or more instead of the projected rate of 6%. Staff size has increased, and the total expenditures for 1977-78 exceeded $62 million.

In the climate of increasing scale, two questions have assumed great importance: Can CMU maintain its current enrollment in the face of a declining student population? How much new income must be generated to accommodate the new demands and to sustain the productive efforts of the different departments and faculties? Both of these questions require that the budget model be more flexible and more complex than the version developed in 1975. A simple extrapolation of income and expense items at different growth rates is insufficient.

A more complex model is also necessary to support the introduction of a "management center" budget system. In order to provide incentives to the deans, CMU has adopted several direct income allocation schemes.[5] One of these is the graduate tuition income sharing plan. Under the plan, colleges receive a portion of the tuition income of their graduate students in excess of a predetermined target. Two of the six colleges are on a "profit center" basis and receive all of their graduate tuition income. The other four receive their budget allocation in two pieces – a general allocation from the central administration and their portion of the graduate tuition income.

THE EFPM EXPERIMENT

In the spring of 1978, the Planning Office prepared the five-year projection of the operating budget using a CMU model implemented with a RSTS-BASIC computer program called DECADE written at Wabash College. DECADE allowed CMU to define variable titles and growth rates or increments. Variables could also be defined as an algebraic function of other variables. However, DECADE did not have any facility for easily changing the initial value of a single variable, and, most importantly, DECADE had no facility for exploring feasible alternatives and trade-offs.

In June 1978, EDUCOM requested that CMU be a test site for EFPM, a generalized system based on the Stanford equilibrium modeling tech-

nique. After reviewing the basic structure of the Stanford models and the preliminary form of the EDUCOM Financial Planning Model, CMU agreed to try to convert the CMU DECADE model to EFPM for several reasons. First, the available structures in EFPM were close enough to those that CMU had been using that EFPM could replicate the CMU model relatively quickly. Second, the structures in EFPM were sufficiently generalized that it would be possible to quickly revise and expand the form of the CMU model to accommodate the requests of the president. Third, the trade-off features of EFPM would allow CMU to explore alternatives in a way that had not been possible at all with DECADE. Finally, because the interfaces with EFPM were comfortable and natural, they encouraged and allowed direct involvement by the vice-presidents and other senior officers.

Once the decision to implement EFPM had been made, the Planning Office at CMU developed a three-step strategy to implement the model within a few weeks. First, the Planning Office staff would learn enough about EFPM and the timesharing system CMS to be able to run the model at Cornell from CMU in Pittsburgh. Second, staff would translate the 5-year projections done in the Spring of 1978 into an EFPM structure and replicate the results. Finally, we would revise both the form and content of the earlier predictions for use during the actual 1980 budget planning sessions in August 1978. Very little time was available to accomplish all of this. In a period of a few weeks during July and August, and in the midst of the myriad of other summer projects and weekly crises, we hoped to accomplish the impossible.

IMPLEMENTING EFPM

After reading over the EFPM documentation sent to me by EDUCOM, I sat down to code the CMU DECADE model in EFPM.[6] Surprisingly, I was able to translate our model with 40 variables into EFPM and to develop specifications for two reports in two hours' time. After this coding was entered into the CMU computer editor, it was then punched out on cards. The card deck was mailed to Cornell, and the data was available on their system in two days.

The next step was to learn CMS, the Cornell computer's operating system, sufficiently well to log into the system, edit the data files, and run EFPM. I arranged to meet with the CMU EDUNET[7] Liaison to learn about CMS and to be introduced to TELENET, the communications link that would connect our terminal in Pittsburgh with the computer in Ithaca. Again, I was pleasantly surprised at the ease with which we got started. Within one hour, and with one fifteen minute phone call to EDUCOM, we were running the People's College test data on EFPM and getting acquainted with the CMS editor.

Now it was time to replicate the results of the earlier CMU projections using an EFPM structure. This was accomplished in one evening on the computer with Daniel Updegrove from EDUCOM on the phone as a coach. Dan helped me to load and run the data files I had mailed to Cornell. By trying to run the EFPM program, I quickly discovered a few typing mistakes and several more logical mistakes in the EFPM translated model. However, as we corrected and changed the data files, I was able to rerun the model and compare the results with our earlier figures. By the end of the evening, the CMU EFPM model and the old model produced almost the same numbers. A few changes the following day allowed me to duplicate exactly the old CMU model. In total, I spent approximately 10 hours of my time and $50 of computer time to replicate the earlier CMU model in EFPM. This first CMU EFPM model was distributed to the participants of the workshop in Indianapolis and is included in this volume as Appendix B.

The final step proved to be the most challenging. Could the CMU projection be expanded and enriched sufficiently to be of use during the initial budget formulation and allocation process? The president and vice presidents were proposing to change the target levels above which we rebated graduate tuition income directly to the colleges. In addition, they had proposed making a five-year projection and actually giving each college within the university an allocation for three years into the future. Both of these changes required that the projection model be more descriptive of the college budgets. It had to allow alternative formulations of the graduate tuition sharing plan and various allocations to the colleges.

The proposed changes to the graduate tuition sharing scheme required that new data be structured in the model. In previous years, the Budget Office had manually calculated the estimated graduate tuition sharing amounts using a constant enrollment estimate. Since most of the income over this level would be returned directly to the colleges for graduate student support, it was not important to make a more accurate initial estimate. Now it was desirable to be able to change assumptions about the parameters for determing the rebates and to forecast accurately the impact of these changes on the college budgets. A new submodel consisting of 8 variables was added to the model with about one hour of work. I also defined a new format to report the results of the graduate tuition rebate analysis.

The original CMU EFPM consisted of 54 data variables and 13 budget functions. The revised model distributed to the Vice President for Management, Director of Finance and Budget Director consisted of 80 variables and 20 budget functions. An additional 10 hours and $50 of computer resources was required to revise the model and prepare reports to be used

in discussion by the budget planning group.

Was it a success? Did the new model provide CMU with the essential tool at the critical time and thereby enable the leaders of the university to make better decisions? The simple answer is "not yet"; but the EFPM model may enable us to make better decisions next year. Analyzing five-year forecasts as part of making one-year budget allocations required more time and effort than it was possible for us to devote this year. The CMU-EFPM model was not sufficiently detailed to allow the president and the provosts to review the next year's budget allocations in a familiar format. Given limited time, the question of projecting budgets beyond 1980 was secondary to the issue of allocating the funds available for 1980. In the final analysis, the five-year projections and future budget problems were not considered in the 1980 allocations that were finally made. The budget for 1980 is balanced, but beyond that there are still unresolved questions.

THE FUTURE

The fact that our first attempt at introducing a five-year model written in the constructs of the EDUCOM Financial Planning Model into the annual budget allocation process did not work is not cause for dismay over EFPM or the long-run health of CMU. The exercise was useful for both participants and we have each learned valuable insights. CMU made several suggestions to EDUCOM concerning the problem of examining incremental budget changes. As a result two new options were added to the forecast option to allow analysis of incremental increases in both absolute and percentage terms. CMU is also continuing to explore the longer-run feasibility of the budget allocations for 1980. The EFPM structure is proving to be very useful for examining the tradeoffs that were so difficult with DECADE. Finally, the Planning Office is rethinking the structure of the CMU model and adding additional detail where appropriate. It may not be possible to develop a financial projection model that will satisfy the specific requirements of the CMU annual budget allocation process and also serve well as a long-run financial feasibility study. However, it is certainly possible to develop a model that will link the two together and allow for an informed exploration of the available alternatives.

Carnegie-Mellon University is a continuously evolving organization like most institutions of higher education. The president of CMU has had different needs for budget and planning analysis at different points in the evolution of the institution. In the early 70's, simple models combined with detailed analysis of key areas like enrollment, research expansion, expense reduction, etc. provided fast answers and a base for more comprehensive modeling in the future. Using this base, a projection model was developed to explore the effects of stable real income over a longer period.

As income began to grow in real terms, the projection model was revised to reflect the higher expectations and to ensure continued budget equilibrium.

Our present task is to understand the structure of a projection model that will shed additional insight on allocating funds to various uses, a job presently performed mostly with experience, intuition and hope. The projection model developed for one purpose was not easily adapted to another. The use of EFPM at CMU is now proceeding on three fronts: 1) refinements to the EFPM financial projection model; 2) development of a non-financial Markov[8] enrollment model using EFPM to project future enrollments and 3) providing an opportunity for direct hands-on experience by the other members of the budget allocation group, especially the Vice-President for Management and the Budget Office.

CONCLUSIONS

What general conclusions can one draw from the CMU experience with EFPM? First, it is relatively easy to translate previous modeling efforts into a model in the EDUCOM framework. EFPM is easy to learn and easy to use. Second, the planner must understand the needs and outlook of the top university officers at the time of model building if it is to be useful to them. Third, the outputs of any model must be presented in a familiar format, and the results and implications must be intuitively meaningful. The president and others are generally not willing to struggle with an unfamiliar budget format. Finally, the model results should allow for analysis of both the short- and the long-term. In the case of CMU, this meant a greater ability to analyze and compare one-year budget alternatives than was available with the model we had constructed. EFPM has been expanded to allow for such incremental comparison in a fairly general way which, I believe, will be helpful to many.

One of the goals of model building is to learn more about the structure of the process being modeled. In that sense, financial planning at Carnegie-Mellon with the EDUCOM Financial Planning Model is a success.

Footnotes

1. Cyert, 1978.
2. Cyert, 1975, Chapman & Van Horn 1974.
3. Rogers, 1975.
4. Massy, 1974.
5. Rogers and Van Horn, 1976.
6. See the first chapter of Part III of this volume.
7. EDUNET is a national computing network for higher education and research.
8. A Markov enrollment model is simply an attrition model in which the number

of students in a given level and college one year is a linear function of the number of students in each level and college the year before. New students entering each year are the only independent variables.

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Modeling the Yale Budget: An Application Using EFPM

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INTRODUCTION

In common with many other colleges and universities, Yale University has been afflicted by growing operating deficits in recent years. The university's deficit rose from $0.1 million in 1973-74 and $0.2 million in 1974-75 to $1.7 million in 1975-76 and $6.6 million in 1976-77. Faced with what appeared to be a growing gap between income and expenses, the Yale Corporation directed the president "to reassess the longer term trends affecting the financial situation of the university."

In December, 1977, the Corporation issued the report "Achieving Financial Equilibrium at Yale: A Report on the Budget" which was prepared by the president and outlined the magnitude of the financial difficulty as well as set forth a general plan of action to correct the problem. It is important to point out that the financial equilibrium which Yale seeks is more than a balanced operating budget. It requires that the institution's consumption of its resources (including endowment and physical assets) not exceed its ability to replenish those resources. Financial equilibrium serves to protect the university's resources over the long-term and insures that current services to the university's constituents will not occur at the expense of future generations (and vice versa). In contrast to the conventional concept of the balanced budget, equilibrium shifts the primary

focus of attention away from current year results toward a consideration of long-term trends in the financial condition.

The concept of financial equilibrium has had a profound impact on the role of planning at Yale. The desire to balance consumption and generation of resources is causing a reassessment of the direction and programs of the university. The effect of the Corporation's decision to freeze spending from endowment and require the rebuilding of plant renovation expenditures is incorporated into the current operating budget making the budget the focal point of the university's financial progress. In this context, the financial projection is more than a tool to anticipate future operating conditions; it is a method to define the university's overall financial condition.

EARLY MODELING AT YALE

During the summer of 1977, a historical analysis of the growth rates of income and expense items was undertaken. This information, combined with estimates of future growth rates of inflation, provided the basis for a hand-calculated five-year projection that included interrelationships between relevant income and expense items. The results of this projection were included in "Achieving Financial Equilibrium at Yale: A Report on the Budget" and indicated a gap of about 0.8% per year between the growth rates of income and expenses. The report mapped out a timetable for corrective actions (shown in Figure 2) that was designed to complete Yale's transition to financial equilibrium by 1982-83. The projection on which this plan was based depended on a set of assumptions about growth rates that were described in a supplement to the report. In order to examine the sensitivity of the base forecast to variations in the assumptions, alternate projections were computed, by hand, using different values for certain key assumptions. Even with a very simple model, hand calculations were very laborious. It became clear that, with the enlarged role of modeling in the financial planning process, a computerized projection model would offer important improvements in speed, flexibility, and scope.

In early June, 1978, a planning group, Roberto Meinrath, Janet Ackerman, John Goldin, and Joseph Epstein, explored ways to implement a computerized model. Three possibilities were considered: 1) adapt Stanford's TRADES model; 2) acquire some other computer modeling package; or 3) develop new computer models.

The planning group discussed a number of criteria for the implementation of the proposed model. First, the program needed to be interactive and easy to use in a conversational way. It should avoid requiring a programmer to stand between the model and the planners who would use its

Figure 1. Separate Modules of the Yale Model

Income
- Term Bill Income
- Investment Income
- Current Gifts
- Indirect Expense Recovery for Grants and Contracts
- Other Income

Expenses
- Faculty Salaries
- Support Staff Salaries and Wages
- Benefits
- Scholarship Aid Expenses
- Utilities
- General Expenses
  - Books
  - Goods and Services
  - Building Services
  - Other Expenses
- Adjustments to Expenses
  - Assessments to Self-Supporting Units
  - Interdepartmental Transfers

output. Second, flexibility of design was a fundamental requirement. A first attempt at a university model is unlikely to emerge as an immutable finished product. The program should be able to evolve easily along with the officers' growing experience with planni..g. Third, to be accepted, the model had to be tailored to the categories and structures familiar to Yale University planners. Users could not be required to learn a new vocabulary to understand the output of the model. Finally, a useable product was needed within three months of starting development.

At the beginning of the discussions, it appeared very likely that only a model developed in-house would satisfy this set of requirements. While detailing specifications for the model, the group learned of the EDUCOM Financial Planning Model (EFPM). At that time, EFPM was in an early stage of development, and a number of important program features did not yet exist. Nonetheless, the completed EFPM would be well suited to Yale's requirements.

The term "model" applied to EFPM is somewhat misleading. One of the important features of EFPM for Yale's purposes was precisely that it did not force the planners to use a pre-existing model structure. Instead, it provided a framework within which it was possible to build a model tailored to this particular institution. Interactive input and output are

handled by EFPM, making the finished model easy to use, while the modelers created the variables and computations that constituted the substance of the model. EFPM substantially reduced the burden of writing interactive computer programs, and this permitted the development effort to concentrate on the conceptual nature and details of the particular model. It was the combination of ease-of-use and flexibility which made EFPM attractive. The general design of Yale's model was already specified before the decision to use EFPM was made. It is a tribute to EFPM's flexibility that it was able to absorb easily that pre-existing design.

ORGANIZATION OF THE YALE MODEL

During the month of June 1978, the planning group proceeded through a series of decisions that defined the organization and scope of the Yale model. The current 1978-79 budget is the base year, and the model provides a five-year projection through 1983-84. Self-supporting units within the university (for example, the Yale University Press) are excluded because projections within those units would, by the definition of "self-supporting," have no effect on the overall operating deficit of the university. Direct grant and contract income and restricted gifts are also excluded because these sources of income do not directly affect the general university deficit.

The model projects income and expense items on a university-wide level. In general, schools and units within the university are not separately represented. However, some exceptions to this rule appeared desirable, as in the case of tuition income and scholarship aid for Yale College, the Graduate School, and the professional schools.

Frequently during model development the planning group had to decide how much detail should be included. Simplicity indicated one variable for tuition rate, but decision planning called for separate rates for Yale College, the Graduate School, and the professional schools. How many categories of employees should be represented? Should utilities expenses be a single item or should the specific types of fuel, such as oil and electricity, be used? These questions and many others were dealt with item by item. A simple model with few items is likely to be easy to use and easy to understand. On the other hand, many variables may be needed to reflect the complexities of the university's situation and to be most useful in planning. In the balance between the simple and the complex it may be true that the planners leaned toward the side of complexity. Thus, budget items were included as separate variables in the model if planning was likely to center at that level of detail. The current working model includes approximately 130 budget items and 90 growth rate variables.

Two techniques helped to prevent the model from becoming un-

wieldy. First and most important, the model was developed as separate modules, each describing an area of the operating budget. Figure 1 shows the different areas: five income areas, six expense areas, and two areas of adjustment to expenses. Each area is modeled separately and the links across area boundaries, such as the effect of a tuition increase on financial aid, are itemized separately for each area.

Modular organization makes revision of the model a simple task. For example, the utilities area was redefined from top to bottom after initial experience with a complete version of the model. This revision required few changes to the rest of the model. A modular organization allows each area to be treated as a separate, manageable problem.

A second technique to keep the model manageable concerns the organization of growth rate variables. To facilitate global changes in growth rates, the model includes a set of variables that adjust categories of growth rate variables. In effect, the growth rate variables form a hierarcy from general to specific. For sensitivity analysis an income item (such as Yale College tuition rate) can be adjusted at four levels: XINCOME, the growth rate of almost all income items; XTERMBIL, the growth rate of all term bill items; XTUITION, the growth rate of all tuition rates; and XYC-TUIT, the growth rate of only Yale College tuition. The Yale College tuition rate is increased by a rate equal to the sum of these four growth rates plus the model's general inflation rate variable. Within the initial model, the adjustment growth rate variables (in this case, XINCOME, XTERMBIL, and XTUITION) are initialized to zero.

Because of the hierarchy of growth rates, users can examine specific or general changes. For example, XTERMBIL affects the growth of all tuition, room, and board items. With XTERMBIL the user can look at the effect of a general change in the growth of all term bill items without dealing with each separate variable.

Detailed discussion of two areas, term bill income and scholarship aid, provides a fuller description of the character of the Yale model. Appendix C, taken from the Yale model user's manual, describes the variables term bill income and scholarship aid. Each section lists the relevant variables (identified by number and by short name) and describes the calculations performed by the model.

Under tuition, there are five types of students: undergraduates, three classes of graduate students, and professional school students. Tuition income is computed as the product of full-time equivalent enrollments and the tuition rate. In each year of the forecast, the tuition rate is grown by its corresponding growth rate variable plus the inflation variable and the hierarchical adjustment variables described above.

Scholarship aid is driven by tuition rates in the model. An increase in

the tuition rate will produce an increase in scholarship aid expense. If one uses the model to examine the effect on the deficit (or surplus) of varying rates of tuition growth, the model will automatically allow for the indirect effects on scholarship aid. Linkages of this sort help to keep the model realistic. The excerpt from the manual describes the linkage between tuition and aid in great detail.

Appendix D shows the section of the EFPM files set up to implement the term bill and scholarship aid areas of the model. The INIT file defines the variables (beginning with the variable numbers shown in the manual) and provides initial Year 1 values. The BFUNC (or budget function) file establishes the calculations within each year of the forecast. For example, the program line "328 * 325 326" tells the model to compute the total Yale College tuition income (to be stored in variable number 328) as the product of tuition rate (variable 325) and FTE enrollment (variable 326). The GFUNC (or growth function) file defines the year-to-year growth calculations. The first line in this section, "325 G 327 273 272 274" means grow variable 325 (Yale College tuition rate) by its corresponding growth rate (variable 327) and by inflation and the other rate adjustment variables. The model is constructed out of a series of calculations of this sort.

CURRENT USE AND FUTURE DEVELOPMENT

Since September of 1978, the Yale model has been used to provide projections to support the work of the University Budget Committee. The model is designed to be easy to use so that technical details will offer no limit to access. So far, the number of people who actually run the EFPM program at Yale is very small. When a more complete User's Manual is available, it will help to ensure that the model will be accessible to all relevant planners within the university.

It is important to recognize that Yale planners do not depend upon the current model to help decide where to make the corrective actions required to bring the budget into equilibrium. Figure 2 shows reductions in expenditures, or corrective action, required for equilibrium under one set of assumptions. Decisions on corrective action involve tradeoffs among programs that cannot be fully addressed by any model. The model is most useful to planners as a tool to assess the overall impact of external factors (energy and the inflation rate) and internal policy decisions (salary increases, tuition rates, and financial aid).

In this role, supporting but not making tradeoff decisions, the model has established itself as a regular part of Yale's planning process.

Future development using EFPM at Yale will most likely center on transferring the modeling technique to subunits within the university.

Figure 2. Yale University Five-Year Plan for Achieving Financial Equilibrium ($ in Millions)

	1978-79	1979-80	1980-81	1981-82	1982-83
Total Projected Deficit Without Corrective Action	$ (9.5)	$ (12.8)	$ (17.4)	$ (20.8)	$ (23.7)
Projected Deficit Adjusted for Corrective Action Taken in Prior Years		$ (8.8)*	$ (5.2)	$ (2.1)	$ (1.3)
Corrective Action	$ 4.0	$ 7.0	$ 5.2	$ 2.1	$ 1.3
Deficit After Corrective Action	$ (5.5)	$ (1.8)	$ 0	$ 0	$ 0

*The $4 million eliminated from the budget base by corrective action in 1978-79 would have increased to $4.3 million, through inflation, in the 1979-80 budget. Similar adjustments have been made across this row in the table.

Source: "Achieving Equilibrium at Yale: A Report on the Budget" (December, 1977)

The planners foresee the possibility of separate, but related, models for the library and specific professional schools. Yale's experience with EFPM has been favorable, and the planners look forward to greater experience and sophistication in its application.

Conclusions

James C. Emery

Drawing general conclusions from a relatively small sample is always somewhat risky. Nevertheless, the experience gained in a variety of institutions that have participated in the planning project has been consistent enough that it is probably valid to draw some generalizations. Among the more useful are the following:

- Higher education will face over the next decade some exceedingly difficult problems that stem primarily from inflation and a reduction in the population of the traditional college-bound age group.
- Financial and strategic planning are important tools for dealing with these problems.
- The choice of a given plan requires the making – either explicitly or implicitly – of an incredibly complex set of inter-related trade-offs among such variables as tuition rates, faculty and staff salaries, budget requests, payout rate from the endowment, targets for alumni gifts, the student-faculty ratio, teaching loads, class size, the ratio between faculty and support staff, and space utilization.
- It is especially appropriate in higher education where open disclosure and rational discussion are prized, to achieve wide participation in the planning process among those who will be affected by resulting plans (the "stakeholders").

- Formal planning models can be developed that adequately represent the relationships among the important quantitative variables of concern to high-level planners.
- Development of a planning model requires that an institution define explicitly the relevant planning variables included in the model and the relationship among the variables (e.g., expected rate of inflation and expected rate of salary increases).
- The explicit specification of planning variables and relationships, and the choice of a plan, provide a discipline for discussion and participation by an institution's stakeholders; in general, this leads to a healthy focus on issues, but it might also bring to the surface some unresolvable political issues that might better be postponed or left implicit.
- The process by which most complex decisions are reached in a college or university defies formalization; tradition, fads, inertia, negotiation, political pressure, barter, hunches, strikes, and demonstrations may all play a part.
- Human judgment is needed to choose a plan that adequately weighs the intangible factors along with the predicted quantifiable effects.
- The collection of data (e.g., average faculty salary) is one of the most crucial, time consuming, and expensive aspects of developing a model.
- A model is much more likely to be successful if it is sponsored by a senior executive ("godfather") who is in a position to act on the resulting plan.
- A model's sponsor should have a background in modeling, or be supported by an "information interpreter" who has an understanding of both the technical aspects of the model as well as the management issues involved.
- A model may be used either for offensive purposes (i.e., to support the adoption of a given plan) or defensive purposes (i.e., to argue against a proposed plan).
- One of the more valuable uses of a model is to explore the sensitivity of outcomes to input data (e.g., the effect on cumulative deficits stemming from a change in the average yield on the endowment); such analyses help to identify critical variables and provide insights about the effects of errors in forecasts.
- A model should be kept as simple as possible in order to make it understandable to non-technical administrators and stakeholders.
- A model should not remain static; it should evolve and adapt in response to changes in the external environment (e.g., Federal

legislation or regulations), institutional needs, or the perceptions of stakeholders.

- Considerable organizational learning typically takes place when an institution gains experience in the use of a model; as a result, the model can gradually evolve toward greater detail and complexity (if this is desirable to achieve greater accuracy and precision) while still remaining understandable to the participants.
- Substantial economic and behavioral barriers exist that inhibit the introduction of formal planning models; among them are the cost of developing a model, lack of adequate technical skills, time commitment of a senior administrator to sponsor the model, the time lag before useful results are obtained, and the risk of failure.
- Reducing the threshold of the barriers can significantly affect an institution's receptivity to a model.
- A successful model must be institution-specific; it cannot be transported from another institution without substantial adaptation to recognized differences in management style, decision variables, relationships among variables, data, and reports.
- Technical means exist to provide users with a generalized planning language that permits specific adaptations while significantly lowering the cost, time, and risk of implementation.
- Although models differ in details across institution, they are often quite similar in general approach, the type of decisions of concern, the details of sub parts of the model, and the process by which the model becomes a part of the organizational culture; consequently, there is substantial benefit for institutions to share their experiences and planning methodology.

It is too early to predict with certainty what might come out of the early work at Stanford and its subsequent adaptations. The signs are exceedingly encouraging, however, that a sizable community of users will come to adopt the general methodology. If this is, in fact, achieved, it is likely to pay handsome dividends. A common and widely used approach for dealing with the challenging planning tasks facing all institutions of higher education would permit an exchange of ideas and experiences that would benefit all.

Appendix A

SUNY-Albany
Determination of Price Trends

Preface:

The financial projection model was designed to simulate the impact of long-run price trends upon the operating budget of the State University of New York at Albany. As such the model is composed of a series of equations of the form:

$$Pjt = Bj=o\ (1 + rj)^t;$$

Bj = the current dollar value of the budgetary item in the base year (i.e., at t=0);

rj = anticipated price trend for the j^{th} item;

t = period for which the projection is being made; and,

Pjt = the projected dollar value of the item in period t.

The limitations of the model are clearly reflected in the above equation. First, it is assumed that the same amount of goods reflected in the base period expenditures will be required throughout the projection period. Secondly, the various price trends are assumed to be constant throughout the projection period and therefore reflect long-range trends. The sources and assumptions implicit in the baseline figures have been discussed elsewhere. This paper is a presentation of the assumptions behind the price indices derived for use in this model.

As previously noted, a constant pattern of expenditures has been assumed. Determination of the appropriate price trends, then, depends upon the definition of the budgetary items to be projected. At present, the most useful configuration is the one that corresponds to actual budgetary classifications. The classifications reflect expenditures for: Instructional Personnel; Non-Instructional Personnel; Temporary Service; Supplies and Expense (non-utilities); Equipment (non-library acquisitions); Utilities; Library Acquisitions; and, Student Aid.

The "price" of any of these 'objects of expenditures' is determined by a number of factors including the national economy, New York State policy (e.g., wage negotiations), local market forces and decisions made by the University at Albany. In general, the procedure has been to assume that none of the "prices" are endogenously determined by either SUNY or the Albany campus. Moreover, it has been assumed that the 'mix' of goods and services would be allowed to remain constant. For example, in determination of faculty salaries such factors as tenure ratios, turnover and salary grades are assumed to be unchanging.

Three principal sources were relied upon in the determination of specific price trends. First, the 'implicit price deflators' found in professional econometric forecasts made by the National Planning Association were examined. Second, internal sources on the Albany campus consulted, notably the members of the Budget Office and the Budget Request (1977-78). Third, reference was made to the experiences of other universities which are members of the project. While each of these sources was referred to in varying degrees, the price trends finally chosen reflect the best judgment of those most directly involved in developing the forecast.

The following paragraphs will discuss how the annual price increase was decided upon for each object of expenditure:

Instructional Salaries - Insofar as it has been assumed that specific market forces will have no impact upon the price trends for faculty salaries, the sole source of inflationary pressure will stem from the desire to maintain a constant standard of living. The most widely used index of the cost of living is the Consumer Price Index (CPI).

Long-range forecasts of the annual increases in the CPI range from 5.6% to 6.7%. The most commonly cited estimate is about 6.0% per annum. This latter rate is that which has been used in projecting desired salary levels for instructional personnel.

Non-Instructional Salaries - The same assumptions made in the case of Instructional Salaries were made in this case and, hence, the price trend is the same.

Temporary Service - The demand and market for Temporary Service are completely different than in the two prior cases. There have been only nominal increases in the prices paid for these services without any diminution of their availability.

A review of recent price trends and estimates made by the Budget Office indicated that a 2% per annum increase would be appropriate.

Supplies and Expense - Whereas the character of the 'objects of expenditure' previously discussed do not vary significantly across different functions, this is not the case with 'Supplies and Expense.' Items purchased in this category vary considerably and so, therefore, may price trends.

In order to determine the extent to which this might be true, a breakdown of 'S&E' for each function was made. The breakdown was based on an expenditure analysis prepared for the Budget Office early in 1977. The results of this analysis and the definition of expenditure categories are presented in Tables I and II, respectively.

Each category of expenditure for 'S&E' was assigned a price index and an implicit trend for the S&E expenditures for each function was derived using a weighted average of the appropriate elements. The price trend assumptions for each general category are presented in the following sections:

General Office and Classroom Supplies - Recent price trends, reflected in the March 1977 Wholesale Price Index (WPI), indicate varying price increases for selected items. For example,

Paper	7.8%
Miscellaneous Metal Products	5.2%

It has been assumed that paper-related expenditures dominate this general category. A rough, weighted-average, consisting of two-thirds paper and one-third metal products, would yield an index of 6.9%.

TABLE I

Percentage Distribution of Expense Categories Within Function

Selected Expense Category (1)	Function, & Dept. Research	Organized Activities	Organized Research	Extension & Public Serv.	Libraries	Student Ser. & Aid	Maint. & Operation	Gen'l Admin.	General Instit. Exp.	Reserve
	P E R C E N T A G E									
General Office & Classroom Supplies	7	18	8	11	13	23	-	11	7	-
Lab Supplies	28	3	15	10	-	-	-	-	-	-
Photographic & Photocopy Supplies	4	23	3	1	3	3	-	-	-	-
Books & Subscriptions (non-Library)	2	2	8	3	-	4	-	3	-	-
Journals (All types)	11	41	9	13	68	28	37	14	40	-
Custodial Supplies	-	1	1	-	-	-	10	-	-	8
Linen Supplies	-	-	-	-	-	-	3	3	4	-
Fuel Supplies, Elec.	1	3	3	1	-	10	23	-	-	13
Grounds Supplies	-	-	-	-	-	-	3	-	-	-
Service Agreements, Contractual Services	20	9	3	23	14	8	14	10	6	21
Travel	18	3	7	1	3	11	-	21	-	-
Fees & Freights	-	1	1	4	-	-	-	3	11	-
Telephone Service & Rentals	3	1	43	-	1	3	-	3	28	-
Printing	6	3	5	25	1	14	-	13	4	1

(1) Cat[illegible]ries are defined in Table II.

TABLE II

S&E Expenditure Classifications

S&E Expenditure Classification Group	Classification Codes	Assumed Price Increase Trend
General Office and Classroom	3000, 3100	5.7
Laboratory Supplies	3125	10.0
Reproduction Supplies	3002, 3105, 3115	5.6
Books and Subscriptions	3010, 3110	6.5
Rentals -		5.5
AV	3135, 3150, 3153	
Equipment	5100—5199	
Real Property	5200	
Custodial Supplies -		6.4
Household	3300	
Paper	3301	
Floor Care	3302	
Automotive	3503—3505, 3512	5.3
Maintenance Supplies	All other 3500 items	6.8
Services and Agreements	3305, 5305—5340 5710—5730, 5800—5899	7.1
Grounds	3530—3532	5.0
Travel	All 4000 items	6.4
Postage	5000—5050	7.0
Telephone	5400—5499	6.5
Printing	5600—5699	6.5

The 'stationery and writing supply' component of the National Planning Association (NPA) long-range forecast of the CPI is 5.7%. While the distribution of items for the CPI may not correspond exactly with SUNYA's expenditures in this area, it was believed that the long-range nature of their forecast (in contrast to that of the WSJ) outweighted the discrepancies likely in composition. Consequently, a price trend of 5.7% was used.

• Laboratory Supplies - Lab supplies vary considerably from discipline to discipline and requirements in this area are to a considerable extent dependent upon enrollment patterns. There is no single index which would appear to be suitable for use as a surrogate. Listed below are general categories of items from the March 1977 WPI which might correspond to Lab items:

Item	Trend
Glass Containers	9.1%
Chemical & Allied Products (general)	3.6%
Pharmaceutical (general)	4.7%
Industrial Chemicals	2.4%
Petroleum-Related Products	11.3%
Paint Materials	20.0%
Rubber Products	6.4%
Hardware	7.5%
TV Replacement Tubes	3.8%
Electrical Machinery & Equipment	4.9%
Medical Lab Tests (from CPI, March 1977)	6.3%

The diverse nature of these supplies make the construction of a specific index difficult. The approach taken was to examine the Budget Request for price increase justifications for Instruction and Departmental Research (I+DR) supplies, weight the price increases for the three major areas in which lab supplies are consumed, and take the resulting composite trend and average it over two years. The reason for the latter procedure lies in the fact that the period from 1975-76 witnessed extraordinary increases which have not been repeated. Further, not all of the consumers of lab supplies rely upon the rapidly increasing price items so that some factor was needed to reduce the composite price trend of general lab supplies. The resulting price trend of 10% appears to be a reasonable surrogate.

Lab Supply Consumer	% of Allocation	Budget Request	Weight
Biology	42%	10.2	4.28
Chemistry	30	17.2	5.16
Physics	28	43.0	12.04
	100%		21.48

Average trend = $(1.2148)^{\frac{1}{2}}$ = 10.0%

Photographic and Photocopy Supplies - Recent price trends for items in this category are:

Item	Source	Trend
Photographic Equipment & Supplies	WPI	2.6%
Paper	WPI	7.8
35mm Film	CPI	7.8
Film Developing Charges	CPI	-1.9
8mm Movie Cameras	CPI	.6

Weighting Photographic Equipment, Film Developing and Movie Camera Price trends by one-third and film and paper by two-thirds; the resulting composite trend is 5.0%. This trend seems to correspond with other trends used in the study.

* Books and Subscriptions - Several different types of items are fixed in this category including newspapers, professional and trade journals and technical books. Some indices considered were:

Item	Source	Trend
Newspapers	CPI - March 1977	4.7%
Magazines	" " "	9.1
Magazines & Newspapers	NPA Forecast	6.4
Books	" "	5.8
Technical Books	Stanford U. trend	13.0 (based upon library acquisition trends)

A simple average of these trends equals 7.8%. Excluding the Stanford U. trend on the grounds that it might reflect an increase in the quantity of items, the rough average is 6.5%. This is close to the N.P.A. long-range forecast for magazines and newspapers and seems an adequate parameter.

* Rentals - The rental price of equipment and structures is assumed to follow closely the increases in the cost of producing these items plus some factor for rental risks and obsolescence. The situation is complicated somewhat with the existence of long-term agreements in which rental rates remain fixed for the negotiated period and, then, rise steeply as prices are renegotiated. Price trends for equipment costs are illustrated below:

Item	Source	Trend
Metal Working Machinery and Equipment	MIP - March 1977	8.0%
General Purpose Machinery	"	6.1
Special Purpose "	"	6.9
Electrical Machinery	"	4.9
Electronic Machinery	"	decrease
Miscellaneous (includes office equipment)	"	4.2
Overall MPI	"	5.9

The MFA forecast for the 'Equipment' component of the GNP anticipates an inflationary trend of 4.5% per annum over the next five years. Overall, an average annual increase of 5.5% would seem to be an appropriate estimate. This would be midway between the average increase in the CPI and the cost of producing the equipment (based upon recent history reflected in the WPI). This is slightly higher than Stanford's estimate for price increases in their equipment budget (5.0%).

• Custodial Supplies - Price trends for major categories of custodial supplies are illustrated below:

Item	CPI-3/77	MFA Forecast
Household Supplies (general)		6.5%
Paper Products		6.5
Paper Towels	6.0%	
Toilet Tissue	14.0	
Floor Care Products		
Cleaning Fluids and Detergents	7.0	4.5

The ratio at which these commodities are consumed is roughly 55% for household supplies, 32% for paper products, and 11% for floor care (assuming a 3% increase) Using this weighting scheme and the MFA forecast assumptions a trend of 6.4% is derived.

• Automotive Supplies and Materials - Recent and forecasted trends for items in this category are illustrated below:

Item	CPI-3/77	MFA Forecast
Gasoline	5.3%	
Motor Oil	3.2	
Tires	7.4 •	
Repairs & Maintenance	6.8 •	
General Maintenance & Repairs Auto (tires & parts)		5.3%

The MAP forecast of 5.3% was used principally because of the long-range assumptions reflected in it.

• Maintenance and Repair Items (General) - Again items in this area range from light bulbs to welding equipment. Several items from the March, 1977 WPI were selected to illustrate the diversity of recent experience.

Item	WPI Trend	Weight
Hand-held Electric Tools	1.4%	.5
General Machinery	6.1	.5
Light Bulbs	9.0	1.0

Item	WPI Trend	Weight
Hardware	7.4%	1.0
Glass	9.4	1.0
Masonry Supplies	6.5	1.0
Parts-Electrical Equipment	4.9	4.0
Plumbing Fixtures	7.9	2.0
Steel & Metal Products	8.3	1.0
Painting-Paint	5.0	3.0
Painting Materials	30.0	3.0

A weighted average of the major items in this yielded an average of 6.8%. This is considerably higher than the CPI component of household maintenance items (both forecast and current) but the nature of SLAC-Albany expenditures seem to warrant the use of this figure.

• Service Agreements, Contractual Services - Recent trends and forecasts for a variety of services are illustrated below:

Type	CPI-3/77	BPA Forecast
Domestic	5.3%	7.1
Washing Machine Repair	5.4	
Auto Repair	6.8	6.0
Drycleaning	6.2	5.9
Legal	7.0	6.8
Bank Services	6.6	4.7
General Overall	7.2	7.1

Although the services consumed by the university vary it seems that, in general, the trend of 7.1% is reasonable. If the CPI is expected to increase by about 6.0% per annum, an increase in Special Services of 7.1% is not unlikely.

• Grounds R&R - The Budget Request reflects an anticipated increase of 9% for items in this category. Relative to other price trends used in the model this figure was considered appropriate.

• Travel - Stanford U. anticipates an average increase of 6.4% in this area. Recent trends are as follows:

Item	CPI-3/77	BPA Forecast
Bus Fares	9.7%	6.0
Airline	7.4	4.8
Rail	7.1	5.0
Taxi	5.3	5.0+

In general, the 6.4% increase seems appropriate.

* Postage and Freight - The trend of 7% per annum increase and anticipated rises in first class mail) is an appropriate figure to use here.

* Telephone - The Budget Request estimate of an increase in the neighborhood of 6.5% seems appropriate.

* Printing - The price trend for printing supplies was assumed to be a function of paper costs, wages and supplies in a 3:1:1 ratio, or approximately 6.5%.

Table III reflects the rates chosen for Supplies and Services by Function.

Utilities - Recent trends in utility and fuel prices show large increases. A sampling of the CPI (March 1977) shows increases over the past year of:

Item	Trend (over past year)
Fuel or Coal (general)	
Utilities	10.4%
Fuel Oil and Coal	11.6
Fuel Oil #2	13.1
Gas and Electricity	12.9
Gas	19.7
Electricity	6.0
Residential Water/Sewer	9.7

The WPI shows even higher increases for fuels. A figure of 15% per annum was chosen because it reflected a conservative estimate and for lack of consensus on any other rate.

Equipment - There is considerable variation between the expected (and past) price trends for equipment. Prices of several types of electronic equipment have decreased. On the other hand, prices of special metal working equipment have risen 8.0%. Commercial furniture has risen 5.3% in the past year.

Item	Source	Trend	
Motor Vehicles	WPI 3/77	5.9%	*
" "	CPI 3/77	4.8	
Commercial Furniture	WPI 3/77	5.3	*
Household Furniture	WPI 3/77	5.8	*
Electrical Machinery	WPI 3/77	4.9	
Household Appliances	WPI 3/77	3.4	*
Home Electronic Equipment	WPI 3/77	-2.1	
Heating Equipment	WPI 3/77	5.5	

TABLE III

Assumed "Supplies and Expense" Price Trend Increases by Function

Function	Price Trend Increase
Instruction and Departmental Research	8.0
Organized Research	6.0
Extension and Public Service	5.7
Organized Activities	6.5
Libraries	5.0
Student Services and Aid	5.0
Maintenance and Operation	5.6
General Administration	5.5
General Institutional Services	5.1
Housing	5.0
OVERALL TOTAL	5.7

An unweighted average of the starred items (*) equals 5.1%. This is somewhat less than the 5.5% annual increase forecast by the HEPA for all types of equipment for 1976-81. The trend of 5.5% was selected as reflecting the need for higher trend items such as furniture, automotive and heavy equipment items.

Library Acquisitions - The price trend associated with library acquisitions was estimated by Stanford to be 13% per annum. Our own Budget Request asks for an increase of 15%. The latter figure was selected for the forecast.

Student Aid - It seems reasonable to assume that student aid should rise at the same rate as the cost of living. For this reason, the 6% price trend was chosen.

Table IV provides a summary of the expenditure growth rates used in the forecast.

TABLE IV

AVERAGE ANNUAL EXPENDITURE GROWTH RATES BY FUNCTION AND OBJECT
(All Figures Represent Assumed Percentage Increase)

Objects of Expenditure	Instr. & Dep't Research	Org. Research	Ext. & Public Service	Org. Activities	Library	Stud. Services & Aid	Maint. and Operation	General Admin.	General Inst'l Services	Housing
Instructional Salaries	6.0									
Non-Instructional Salaries	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Temporary Service	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Supplies & Expense	6.0	6.0	5.7	4.5	5.0	5.0	5.4	5.3	5.1	5.0
Utilities							15.0			15.0
Equipment	5.5	5.5	1.3	5.5	5.5	5.5	5.5	5.5	5.5	5.5
Library Requisitions					15.0					
Student Aid						6.0				

Appendix B

Carnegie-Mellon University

Preliminary Implementation* of EFPM The EDUCOM Financial Planning Model

by
Frederick Rogers
Director of Planning and Systems
Carnegie-Mellon University

August 25, 1978

* This is a report of work in progress prepared for the Workshop on Computer-Based Financial Planning Models, August 29-31, 1978. Quotation or further reproduction is prohibited without permission of the author.

```
>*  Sample run of the EDUCOM Financial Planning Model (EFPM)
>*  using the Carnegie-Mellon University input data
>*
>*  user entries are in lower case preceded by >
>*  user entries beginning with asterisks are comments.
>*
>efpm
EFPM - VERSION OF AUGUST 26, 1978

FOR INFO ON LATEST CHANGES, ADD EFPM AND TYPE: CHANGES
REPORT PROBLEMS TO DAN UPDEGROVE AT 609-921-7575.

08/26/78  TIME:  20:59:26
EFPM USER INPUT DATA SUMMARY-
NUMBER OF ENTRIES IN THE 6 USER FILES-
VARIABLES RF OF REPTS STEPS CONSTRAINTS:
    54    13   3   5    19         1

FORECASTS WILL BE DONE IN NOMINAL TERMS.
BASE 10-YEAR FORECAST RUN AUTOMATICALLY.
TRIAL YEAR-1 VALUES COPIED FROM BASE.

ENTER OPTION:
>forecast

ENTER BASE OR TRIAL:
>base

ENTER END YEAR (AND START YEAR):
>5

FORECAST IS FEASIBLE

 2)  5 YEAR     BASE FORECAST

BUDGET SUMMARY                                          08/26/78  1

                              1978        1979        1980        1981        1982

NET INCOME AVAILABLE         26218.      28019.      30049.      32195.      34479.
TOTAL EXPENSES               26079.      27948.      29974.      32126.      34438.
SURPLUS                        139.         71.         75.         69.         40.
CUM. SURPLUS/DEFICIT           139.        210.        285.        354.        395.


ENTER REPORT NO:
>*       comment: feasibility is defined as surplus between $10 thousand and
>*       and $1 million

>*          an entry of zero will show the list of reports-
>0
```

```
REPORT NUMBERS AND TITLES:
 1  FPY'S
 2  BUDGET SUMMARY
 3  INCOME DETAIL
 4  EXPENSE DETAIL
 5  SUMMARY - INCOME & EXPENSE

ENTER REPORT NO:
>3

 3)  5 YEAR     BASE FORECAST

INCOME DETAIL                                                  08/26/78  2

                          1978        1979        1980        1981        1982

ENROLLMENT - FTE
UNDERGRADUATE FTE         3462.       3450.       3450.       3425.       3425.
GRADUATE FTE               700.        700.        700.        700.        700.

TUITION RATES
UNDERGRADUATE RATE         3.70        4.10        4.50        4.90        5.30
GRADUATE RATE              4.00        4.40        4.80        5.20        5.60


INCOME
UNDERGRADUATE TUITION     12809.      14145.      15525.      16782.      18152.
GRADUATE TUITION           2800.       3080.       3360.       3640.       3920.
SPECIAL FEES                211.        211.        211.        211.        211.
TOTAL TUITION INCOME      15820.      17436.      19096.      20633.      22283.

ENDOWMENT INCOME - E&GO    5414.       5685.       5900.       6200.       6500.
CURRENT FUND INVEST INC     350.        364.        379.        394.        409.

UNRESTRICTED GIFT - E&GO    330.          0.          0.          0.          0.
RESTRICTED GIFTS - E&GO     333.        130.          0.          0.          0.
TOTAL GIFT INCOME           663.        130.          0.          0.          0.

CMU OVERHEAD RECOVERY      2800.       2968.       3146.       3335.       3535.
CMIR OVERHEAD RECOVERY     1100.       1388.       1500.       1622.       1754.
TOTAL OVERHEAD RECOVERED   3900.       4356.       4646.       4957.       5289.

MISC INCOME                 740.        784.        831.        881.        934.
SUBTOTAL INCOME           26887.      28755.      30852.      33065.      35416.

GRAD TUITION TRANSFER       669.        736.        803.        870.        937.

NET INCOME AVAILABLE      26218.      28019.      30049.      32195.      34479.
SURPLUS                     139.         71.         75.         69.         80.
```

ENTER REPORT NO:
>4

4) 5 YEAR BASE FORECAST

EXPENSE DETAIL 08/26/78 3

EXPENSES	1978	1979	1980	1981	1982
INSTRUCTION & DEPT RES					
CIT	3517.	0.	0.	0.	0.
MIS	4124.	0.	0.	0.	0.
CFA	2707.	0.	0.	0.	0.
H&SS	2131.	0.	0.	0.	0.
STATISTICS	270.	0.	0.	0.	0.
UNIV PROF	49.	0.	0.	0.	0.
TOTAL INSTRUCT & DEPT RS	12798.	13690.	14648.	15673.	16770.
SUPPORTING ACADEMIC EXP	1328.	1408.	1520.	1642.	1773.
UNDGRAD FINANCIAL AID	1281.	1414.	1552.	1678.	1815.
ADMINISTRATIVE & BUS EXP	4554.	4827.	5117.	5424.	5749.
PHYSICAL PLANT EXPENSES	2312.	2474.	2647.	2832.	3031.
UTILITIES	2690.	2959.	3255.	3580.	3938.
GENERAL INSTIT EXP	1120.	1176.	1235.	1297.	1361.
TOTAL EXPENSES	26079.	27948.	29974.	32126.	34438.
SURPLUS	139.	71.	75.	69.	40.

ENTER REPORT NO:

>5

5) 5 YEAR BASE FORECAST

SUMMARY - INCOME & EXPENSE 08/26/78 4

INCOME	1978	1979	1980	1981	1982
TOTAL TUITION INCOME	15820.	17436.	19096.	20633.	22283.
ENDOWMENT INCOME - E&OO	5414.	5685.	5900.	6200.	6500.
TOTAL GIFT INCOME	663.	130.	0.	0.	0.
CURRENT FUNE INVEST INC	350.	364.	379.	394.	409.
TOTAL OVERHEAD RECOVERED	3900.	4356.	4646.	4957.	5289.
MISC INCOME	740.	784.	831.	881.	934.
SUBTOTAL INCOME	26887.	28755.	30852.	33065.	35416.
GNAD TUITION TRANSFER	669.	736.	803.	870.	937.
NET INCOME AVAILABLE	26218.	28019.	30049.	32195.	34479.
EXPENSES					
TOTAL INSTRUCT & DEPT RS	12794.	13690.	14648.	15673.	16770.
TOTAL EXPENSES	26079.	27948.	29974.	32126.	34438.
SURPLUS	139.	71.	75.	69.	40.

```
ENTER REPORT NO:
>1

 1)  5 YEAR     BASE FORECAST

PPV'S                                                          08/26/78  5

                                    1978        1979        1980        1981        1982
INFLATION RATE - GENERAL            1.06        1.06        1.06        1.06        1.06
INFLATION RATE - SALARIE            1.07        1.07        1.07        1.07        1.07
INFLATION RATE - UTILITI            1.10        1.10        1.10        1.10        1.10
INFLATION RATE - LIBRARI            1.06        1.08        1.08        1.08        1.08
INFLATION RATE - GENL IN            1.05        1.05        1.05        1.05        1.05
CMIR GROWTH RATE                    1.19        1.02        1.02        1.02        1.02
UNDERGRAD FIN AID FRACT             0.10        0.10        0.10        0.10        0.10

ENTER REPORT NO:
>*     an exclamation point indicates no more reports needed    !

ENTER END YEAR (AND START YEAR):
>*     another exclamation point moves one level higher         !

ENTER BASE OR TRIAL:
>*     ditto     !

ENTER OPTION:
>tradeoff

ACTIVE CONSTRAINT SUMMARY-
NUMBER, STARTING YEAR, ENDING YEAR:
  1          1 (1978)      10 (1987)

ENTER END YEAR FOR TRADEOFFS:
>2                    * a 2-year calculation of slack in the ppv's

FORECAST IS FEASIBLE

ENTER TRADEOFF SUB-OPTION:
>all                  * show each ppv taken singly

CURENT STATUS OF PPV'S AND CONSTRAINTS-
  ID, NAME,     VALUE, STATUS,  MIN,  MAX:

100 INFLGENL      1.06 OK       0.85      4.21
101 INFLSALY      1.07 OK       1.01      1.07
102 INFLUTIL      1.10 OK       0.75      1.12
103 INFLLIBY      1.06 OK       0.36      1.11
104 INFLGENI      1.05 OK       0.22      1.10
106 INFLCMIR      1.19 OK       1.14      1.99
113 UNGFNAID      0.10 OK       0.03      0.10


ENTER TRADEOFF SUB-OPTION:
>!!!!end              * back to the top of the tree, then end
SYSTEM RESOURCES USED (CPU SECONDS)
08/26/78  TIME: 21:15:01  VCPU:   1.6  TCPU:   2.6
END OF EFPM
```

Carnegie-Mellon University
EFFM Data Files
August 25, 1978

```
>* File 1: Data definitions
>t init1 data

  1                                    1   ENROLLMENT - FTE
  2  UNDGENRL          3462              UNDERGRADUATE FTE
  3  GRADENRL           700              GRADUATE FTE
  5                                    1   TUITION RATES
  6  UNDGTUIT          3.700              UNDERGRADUATE RATE
  7  GRADTUIT          4.000              GRADUATE RATE
  0
 10  INCOME                               1   INCOME
 11  UNDGINC                              UNDERGRADUATE TUITION
 12  GRADINC                              GRADUATE TUITION
 13  SPECFEES           211               SPECIAL FEES
 14  TUITINC                              TOTAL TUITION INCOME
  0
 21  ENDINC            5414              ENDOWMENT INCOME - E&OO
  0
 25  UNRSGIFT           330              UNRESTRICTED GIFT - E&OO
 26  RESTGIFT           333              RESTRICTED GIFTS - E&OO
 27  GIFTINC                              TOTAL GIFT INCOME
  0
 29  CURFDINV           350   105        CURRENT FUNE INVEST INC
  0
 30  CMUOVREC          2800   100        CMU OVERHEAD RECOVERY
 31  CMIROVRE          1100   100        CMIR OVERHEAD RECOVERY
 34  RESOVINC                             TOTAL OVERHEAD RECOVERED
  0
 39  MISCINC            740   100        MISC INCOME
  0
 40  TRANSFER                             GRAD TUITION TRANSFER
 45  SUBTINC                              SUBTOTAL INCOME
 50  TOTALINC                             NET INCOME AVAILABLE
  %
  0
 60  EXPENSES                         1   EXPENSES
 62  INSTDPRS                         1   INSTRUCTION & DEPT RES
 64  CITEXP            3517               CIT
 65  MISEXP            4124               MIS
 66  CFAEXP            2707               CFA
 67  H&SSEXP           2131               H&SS
 68  STATEXP            270               STATISTICS
 69  UNIVPROF            45               UNIV PROF
 70  INSTEXP          12794   101        TOTAL INSTRUCT & DEPT RS
  0
 80  SUPACEXP          1328   103        SUPPORTING ACADEMIC EXP
 85  STAIDEXP                 100        UNDGRAD FINANCIAL AID
 90  ADMINEXP          4554   100        ADMINISTRATIVE & BUS EXP
 93  PHPLTEXP          2312   101        PHYSICAL PLANT EXPENSES
 95  UTILEXP           2690   102        UTILITIES
 97  GENINEXP          1120   104        GENERAL INSTIT EXP
 98  TOTALEXP                             TOTAL EXPENSES
 99  SURPLUS                              SURPLUS
```

```
100  INFLGENL          1.05          INFLATION RATE - GENERAL
101  INFLSALY          1.07          INFLATION RATE - SALARIES
102  INFLUTIL          1.10          INFLATION RATE - UTILITIES
103  INFLLIBY          1.06          INFLATION RATE - LIBRARIES
104  INFLGENI          1.05          INFLATION RATE - GENL INST
105  INFLCONS          1.04          CONSERVATIVE INFLATION RATE
106  INFLCMIR          1.10          CMIR GROWTH RATE
107  INFLTUIT          1.02          REAL GROWTH - TUITION
108  INFLENDW          1.04          REAL GROWTH - ENDOWMENT
  0
110  INCRTUIT          .400          TUITION INCREASE
112  GRADTUSH          .239          GRADUATE TUIT SHARING $
113  UNGFNAID          .100          UNDERGRAD FIN AID FRACT
0
200  ZERO              0.0           ZERO FOR INITIALIZATION
201  CUMSURP                         CUM. SURPLUS/DEFICIT
(99)

R;

>*   budget functions
>t bfunc1 data

 11 *   2   6                                  * UNDERGRAD TUITION
 12 *   3   7                                  * GRADUATE TUITION
 14 +  11  12  13                              * TOTAL TUITION
INCOME
 27 +  25  26                                  * TOTAL GIFT INCOME
 34 +  30  31                                  *TOTAL RESEARCH
OVHD INCOME
 45 +  14  21  27  29  34  39                  *SUBTOTAL INCOME
 48 *  12 112                                 * GRADUATE TUITION
TRANSFER
 50 -  45  48                                  * NET INCOME
AVAILABLE
 85 *  11 113                                 * UNDGRAD FINANCIAL
AID
 98 +  70  80  85  90  93  95  97              * TOTAL EXPENSES
 99 -  50  98                                  * SURPLUS

201 I 200                                      * INIT CUM SURPLUS
201 + 201  99                                  * CUM SURPLUS /
DEFICIT

R;

>*   growth functions  (in addition to price increases)
>t gfunc1 data

  6 +   6 110                                  *  UNDERGRADUATE
TUITION RATE
  7 +   7 110                                  *  GRADUATE TUITION
RATE
 31 *  31 106                                  *  CMIR OVERHEAD
RECOVERY
```

```
>*   report constants
>t rept1 data

01  PPV'S
01  01   100 101 102 103 104 106 113 999

02  BUDGET SUMMARY
02  03    00  50  98  99 201 999

03  INCOME DETAIL
03        01  02  03  00  05  06  07  00  00  10  11  12  13  14
00
03        21  25  26  27  29  00  30  31  34  00  39  45  00  40
00
03        50  99 999

04  EXPENSE DETAIL
04        60  62  64  65  66  67  68  69  70  00  80  85  90  93
95
04        97  00  98  99 999

05  SUMMARY - INCOME & EXPENSE
05  32    10  14  21  27  29  34  39  00  45  40  50  00  60  70
98
05        00  99 999

R;


>*   step increments for years 2 - n
>t apttep1 data

  2  UNDOENRL   NR   2       3450      3450      3425      3425
 25  UNRSGIFT   NR   2          0
 26  RESTGIFT   NR   2        130         0
 26  RESTGIFT   NR   3          0
 21  ENDINC     NR   2       5685      5900      6200      6500
 64  CITEXP     NR   2          0
 65  MISCEXP    NR   2          0
 66  CFAEXP     NR   2          0
 67  H&SSEXP    NR   2          0
 68  STATEXP    NR   2          0
 69  UNIVPROF   NR   2          0
106  INFLCMIR   NR   2      1.020
107  INFLLIBT   NR   2      1.080

R;

>*   constraints
>t cons1 data

 99  SURPLUS          10.0      900.0  1   MINIMUM SURPLUS OF
$10,000.

R;
```

Appendix C

Yale University EFPM Model
Explanation of Term Bill Income

Tuition

Tuition income is computed as the product of FTE enrollment and tuition rate. The tuition rate is grown by its appropriate real growth rate and inflation to produce future year forecasts. The relevant variables are summarized in the table below. The professional school tuition rate is a weighted average of all the professional schools included in the model.

	Tuition Variables				Real growth
	FTE Enrollment		Tuition Rate		rate of tuition
Yale College	326	YC-FTE	325	YC-TUIT	327 RYC-TUIT
Graduate Full tuition	330	G-FTE7	329	G-TUIT7	331 RG-TUIT
Graduate 4th year tuition	334	G-FTE4	333	G-TUIT4	331 RG-TUIT
Dissertation fee	338	G-FTED	337	G-DISS	not grown
Average Prof. Schools	342	P-FTE	341	P-TUIT	343 RP-TUIT

The transfer to medicine reflects graudate school tuition received from Ph.D. candidates who are trained by Medicine. It is grown by the same variable that grows Yale College tuition rate.

Transfer to medicine	250	TR-TMED	Grown by:	327	RYC-TUIT

Room and Board Income

The following totals are grown by their respective growth rates:

	Variable		Real growth Rate	
Yale College Room	323	YC-RMBAS	347	RYC-RM
Yale College Board	324	YC-BDBAS	344	RYC-BD
Other Room	353	TR-OTHRM	354	RTR-ORM
Other Board	355	TR-OTHBD	356	RTR-OBD

Effects of Changing FTE Enrollment

FTE's should not be changed in the first year; the 1978-79 figures represent base amounts. Changing FTE's in later years directly effects tuition income. Changing Yale College's FTE's has some effect on Yale College Room and Board. Each incremental student enrollment is assumed to add some fraction of one room and one board contract. The exact fractions can be altered using two variables:

(10/20/78)

Fraction of room contract per new student .345 YC-RMI

Fraction of board contract per new student .335 YC-BDI

Initial values for these coefficients were selected to reflect net incremental income. The room coefficient has initially been set to 0 to reflect the fact that Yale is a full room capacity. The board coefficient has been set to .10; it was assumed that each new student represents .20 board contracts, but that half of this is offset by increased expenses.

Graduate and professional school FTE enrollments have no effect on other room and board income.

Remote Effects

FTE enrollments, tuition rates, and term bill rates directly affect scholarship aid expense. See the description of scholarship aid expense. In particular, the growth rates for Yale College term bill rates should not be changed without also reviewing the growth rate of the maximum self-help level.

(10/20/78)

Yale College

The model conforms to the guaranteed aid policy in Yale College. The number of aid students is multiplied by the average gift need of aid students and reduced by outside scholarship gift. Thus the term bill rate directly effects scholarship aid.

$$\text{Total Aid} = \underbrace{(b \times E)}_{\substack{\text{\# of} \\ \text{aid students}}} \times \underbrace{[T + J - S - F]}_{\substack{\text{average} \\ \text{gift need}}} - \underbrace{O}_{\substack{\text{outside} \\ \text{scholarship}}}$$

Symbol	Description	Variable		Real Growth Rate	
E	Base FTE enrollment	336	YC-FTE	-	
b	% of students on aid	370	SA-YCE	-	
T	Term bill (tuition + room + board)	sum of term bill rates		-	
J	additional expenses (e.g., travel, personal)	373	SA-JUNE	377	ESA-JUNE
F	average family contribution	371	ESA-FC	375	ESA-HELP
S	maximum self-help level	372	SA-SELFH	376	ESA-HELP
O	total outside scholarship	374	SA-OUT	378	ESA-OS

Effect of changes in FTE's. The above aid computation is performed on the base FTE enrollment in year 1. The effect on aid of additional students can be different than the average effect of base students. The procedure for computing aid to incremental students is 1) compute the average Yale gift to base aid students (Total Aid ÷ (b x E)); 2) compute the number of incremental aid students as b times the number of incremental students; 3) aid to incremental aid students is computed as the number of incremental aid students times some proportion of the average gift to base students. This proportion is controlled by variable 470. This variable is useful, for example, if one wishes to examine the effect of additional special students. Special students receive no aid so variable 470 would be set to zero.

Graduate and Professional Schools

Aid in the graduate and professional schools is taken as the product of the number of aid packages times the average dollars per package. The equations are summarized on the following page.

(11/9/78)

	(1) FTE	*	(2) fraction of FTE w Pckg.	(3) tuition rate	(4) package size as fraction of tuition
Graduate	FTE of full and 4th year		306 GA-GRE	329 G-TUIF	367 GA-GRES
Professional	342 P-FTE		368 GA-FE	341 P-TUIT	369 GA-FES
	number of packages			size of package	

Total Aid = (1) x (2) x (3) x (4)

It is useful to remember that the product of (2) and (4) is equal to aid as a proportion of tuition income.

Health Center and Other Aid

	Variable	Real Growth Rate
Health Center and other aid	383 GA-HLTH	387 EGA-HLTH

Remote Effects

Scholarship aid (except for health center and other aid) is computed entirely from information about term bill rates and FTE enrollments.

Reports

#17 Scholarship Aid
#18 Scholarship Aid Detail - includes coefficients
#19 Assumptions - Term Bill Income and Scholarship Aid

(11/9/78)

Yale University

Modified Implementation * of EFPM the KENCOM Financial Planning Model

by

Janet Ackerman

and

John Goldin

Yale University

August 25, 1978

* Selected data values shown in this report have been changed to protect the confidentiality of the Yale administration. The report does, however, accurately reflect the structure and operating characteristics of the Yale implementation of EFPM.

This is a report of work in progress prepared for the Workshop on Computer-Based Financial Planning Models, August 29-31, 1978. Quotation or further reproduction is prohibited without permission of the authors.

```
>* Sample run of the EDUCOM Financial Planning Model (EFPM)
>* using the modified Yale University input data.
>* User entries are in lower case preceded by >
>* user entries starting with asterisks are comments.


>efpm
EFPM - VERSION OF AUGUST 25, 1978

FOR INFO ON LATEST CHANGES, RUN EFPM AND TYPE: CHANGES
REPORT PROBLEMS TO DAN SPERDUTO AT 609-921-7575.

08/26/78  TIME:  21:29:32
EFPM USER INPUT DATA SUMMARY.
NUMBER OF ENTRIES IN THE 6 USER FILES.
VARIABLES DF OF REPTS STEPS COMSYNA(RTS)
   366   310 104  30    60        )

FORECASTS WILL BE DONE IN NOMINAL TERMS.
BASE 10-YEAR FORECAST RUN AUTOMATICALLY.
TRIAL YEAR-1 VALUES COPIED FROM BASE.

ENTER OPTION:
>forecast

ENTER BASE OR TRIAL:
>base

ENTER END YEAR (AND START YEAR):
>4 1
8
FORECAST IS INFEASIBLE

 1)  4 YEAR    BASE FORECAST

SHORT SUMMARY: FOR OVERALL SUMMARY, REQUEST REPORT #0.       08/26/78  1

                          1978       1979       1980       1981
TOTAL INCOME             99797.    100719.    107049.    114208.

TOTAL EXPENSES           99345.    106478.    114840.    123809.

SURPLUS/DEFICIT(-)        -3548.     -5761.     -7791.     -9601.
```

```
ENTER REPORT NO:
>2

 2)  4 YEAR    BASE FORECAST

SUMMARY OF OPERATING RESULTS -- FOR ASSUMP., SEE REPORT #06. 08/26/75  2

                          1978        1979        1980        1981
INCOME

TERM BILL INCOME         48907.      52691.      56759.      61165.
GRANTS&CONTRACT-INDIRECT  5166.       5916.       5980.       6331.
NET INVESTMENT INCOME    23146.      24225.      29062.      25239.
GIFTS FOR CURRENT USE     5579.       5579.       5907.       6213.
OTHER INCOME             11999.      12703.      13971.      14297.

TOTAL INCOME             94797.     100715.     107049.     113029.

CALC. GWTH OF INCOME       6.29        6.29        6.71        6.71

EXPENSES

FACULTY SALARIES         21950.      23532.      25170.      26941.
SUP STAFF WAGE & SALARY  35453.      37742.      40182.      42994.
NET DEF.AFFECT. BENEFITS  6007.       6581.       7170.       7822.
STUDENT SCHOLARSHIP AID  11078.      11950.      12889.      13901.
GENERAL EXPENSES         34393.      36052.      40578.      84102.
UTILITY COST(BASE+ADDED)  9999.      10918.      11948.      12501.

SUBTOTAL OF EXPENSES     118923.     126273.     137946.     148942.

ASSESSMENTS               8933.       8863.       9651.      10195.
ID CREDITS               12145.      12934.      13658.      14417.

TOTAL EXPENSES           98345.     106476.     116480.     123829.

CALC. GWTH OF EXPENSES:    8.27        7.67        8.02        8.02

SURPLUS/DEFICIT(-)       -3948.      -8761.      -7591.      -9501.

CONSUMER PRICE INDEX       0.05        0.06        0.06        0.06


ENTER REPORT NO:
>4
```

4) 4 YEAR BASE FORECAST

TERM BILL INCOME. 08/26/78 3

	1978	1979	1980	1981
YALE COLLEGE TUITION	24250.	26190.	28285.	30548.
YALE COLLEGE BOARD	5270.	5639.	6034.	6456.
YALE COLLEGE ROOM	4821.	5158.	5520.	5906.
TOTAL YALE COLLEGE	34341.	36987.	39838.	42910.
GRADUATE-FULL TUITION	5801.	6265.	6766.	7307.
GRADUATE 4TH YR TUITION	820.	886.	956.	1033.
GRAD. DISSERTATION FEE	27.	27.	27.	27.
TRANSFER TO MEDICINE	-583.	-630.	-680.	-734.
TOTAL GRADUATE SCHOOL	6065.	6548.	7070.	7633.
TOTAL PROFESSIONAL SCHLS	5993.	6472.	6990.	7549.
OTHER ROOM	1845.	1974.	2112.	2260.
OTHER BOARD	663.	709.	759.	812.
--------TOTAL--------				
TERM BILL INCOME	48907.	52691.	56769.	61165.
CALC. GRWTH OF TB TOTAL	7.74	7.74	7.74	7.74
YALE COLL. TUIT. RATE	4.85	5.24	5.66	6.11
YALE COLLEGE FTE	5000.	5000.	5000.	5000.
YALE COLLEGE TUITION	24250.	26190.	28285.	30548.
$INCR BD INC-NEW FTE'S	0.10	0.10	0.10	0.10
YALE COLL. BOARD RATE	1.96	1.29	1.33	1.42
# OF INCREMENTAL FTE'S	0.0	0.0	0.0	0.0
INCREMENTAL BOARD INCOME	0.0	0.0	0.0	0.0
YALE COLLEGE BOARD BASE	5270.	5639.	6034.	6456.
YALE COLLEGE BOARD	5270.	5639.	6034.	6456.
$INCR RM INC-NEW FTE'S	0.0	0.0	0.0	0.0
YALE COLLEGE ROOM RATE	1.05	1.12	1.20	1.28
INCREMENTAL ROOM INCOME	0.0	0.0	0.0	0.0
YALE COLLEGE ROOM BASE	4821.	5158.	5520.	5906.
YALE COLLEGE ROOM	4821.	5158.	5520.	5906.
GRAD. FULL TUIT. RATE	4.85	5.24	5.66	6.11
GRADUATE FTE - FULL	1196.	1196.	1196.	1196.
GRADUATE-FULL TUITION	5801.	6265.	6766.	7307.
GRAD.-4TH YR TUIT RATE	1.73	1.87	2.02	2.18
GRADUATE FTE - 4TH YR	474.	474.	474.	474.
GRADUATE 4TH YR TUITION	820.	886.	956.	1033.
GRADUATE DISS. FEE	0.10	0.10	0.10	0.10
GRADUATE FTE - DISS.	274.	274.	274.	274.
GRAD. DISSERTATION FEE	27.	27.	27.	27.
TRANSFER TO MEDICINE	-583.	-630.	-680.	-734.
TOTAL GRADUATE SCHOOL	6065.	6548.	7070.	7633.
PROF. TUITION RATE	3.97	4.29	4.64	5.01
PROFESSIONAL SCHLS FTE	1508.	1508.	1508.	1508.
TOTAL PROFESSIONAL SCHLS	5993.	6472.	6990.	7549.
OTHER ROOM	1845.	1974.	2112.	2260.
OTHER BOARD	663.	709.	759.	812.
--------TOTAL--------				
TERM BILL INCOME	48907.	52691.	56769.	61165.

ENTER REPORT NO:
>19

19] 9 YEAR BASE FORECAST

ASSUMPTIONS — TERM BILL AND STUDENT AID. 08/26/78 5

	1978	1979	1980	1981
REAL GROWTH RATES: CPI+X				
TERM BILL INCOME				
GROWTH-DALE COLL TUIT	0.02	0.02	0.02	0.02
GROWTH-GRAD. TUITION	0.02	0.02	0.02	0.02
GROWTH-PROF SCHLS TUIT	0.02	0.02	0.02	0.02
GROWTH - YC ROOM RATE	0.01	0.01	0.01	0.01
GROWTH - YC BOARD RATE	0.01	0.01	0.01	0.01
GROWTH-OTHER ROOM	0.01	0.01	0.01	0.01
GROWTH-OTHER BOARD	0.01	0.01	0.01	0.01
STUDENT SCHOLARSHIP AID				
GROWTH-FAMILY CONTRIB.	0.02	0.02	0.02	0.02
GROWTH-SELF HELP LEVEL	0.02	0.02	0.02	0.02
GROWTH-M.&C. BUDGET	0.01	0.01	0.01	0.01
GROWTH-OUTSIDE SCHOL	-0.01	-0.01	-0.01	-0.01
GROWTH OF OTHER AID	0.01	0.01	0.01	0.01
COEFFICIENTS				
TERM BILL INCOME				
$INCR RM INC-NEW FTE'S	0.0	0.0	0.0	0.0
$INCR BD INC-NEW FTE'S	0.10	0.10	0.10	0.10
STUDENT SCHOLARSHIP AID				
% OF GRAD FTE-AID PCHG	0.77	0.77	0.77	0.77
% OF FULL GRAD TUIT	0.84	0.84	0.84	0.84
% OF PROF FTE-AID PCHG	0.60	0.60	0.60	0.60
% OF PROF TUITION	0.52	0.52	0.52	0.52
% OF YC FTE ON AID	0.39	0.39	0.39	0.39
NEW FTE-% OF AVG. AID	0.90	0.90	0.90	0.90
CONSUMER PRICE INDEX	0.06	0.06	0.06	0.06

ENTER REPORT NO:
>17

17) 4 YEAR BASE FORECAST

SCHOLARSHIP AID. FOR DETAIL, SEE #18; FOR ASSUMP., SEE #19. 08/26/78 6

	1978	1979	1980	1981
TALB COLLEGE AID	9770.	9130.	9535.	9961.
GRADUATE SCHOOL AID	9280.	9601.	9969.	9386.
PROFESSIONAL SCHOOL AID	1883.	2039.	2196.	2372.
HEALTH CENTER AND OTHER	185.	177.	189.	200.
---------TOTAL---------				
STUDENT SCHOLARSHIP AID	11078.	11950.	12889.	13901.
CALC. GROWTH OF STUD AID	7.87	7.86	7.85	7.85
AID AS % OF TU INCOME	0.03	0.03	0.03	0.03

ENTER REPORT NO:
>18

18) 4 YEAR BASE FORECAST

SCHOLARSHIP AID DETAIL. FOR ASSUMPTIONS, SEE REPORT #19. 08/26/78 7

	1978	1979	1980	1981
% OF TU FYB GR AID	0.38	0.38	0.38	0.38
AVG. FAMILY CONTRIB.	3.85	3.86	3.40	3.34
MAXIMUM SELF HELP	3.12	3.09	3.07	3.07
MISC. STUDENT BUDGET	1.00	1.07	1.14	1.23
OUTSIDE SCHOLARSHIP	1684.	1797.	1915.	1931.
TALB COLLEGE AID	9770.	9130.	9535.	9961.
NEW FYB-% OF AVG. AID	0.90	0.90	0.90	0.90
AVERAGE TALB COLL. GIFT	2.44	2.63	2.83	3.05
% OF GRAD FYB-AID PCBO	0.77	0.77	0.77	0.77
% OF FULL GRAD TUIT	0.84	0.84	0.84	0.84
GRADUATE SCHOOL AID	9280.	9601.	9969.	9386.
% OF PROF FYB-AID PCBO	0.60	0.60	0.60	0.60
% OF PROF TUITION	0.50	0.50	0.50	0.50
PROFESSIONAL SCHOOL AID	1883.	2039.	2196.	2372.
HEALTH CENTER AND OTHER	185.	177.	189.	200.
---------TOTAL---------				
STUDENT SCHOLARSHIP AID	11078.	11950.	12889.	13901.
CALC. GROWTH OF STUD AID	7.87	7.86	7.85	7.85
AID AS % OF TU INCOME	0.03	0.03	0.03	0.03

```
                    YALE RFPM IMPLEMENTATION
              Term Bill Income and Student Aid Only

          (Selected initial values have been changed)
                        August 25, 1978

                  File 1: Data Definitions (minimal)

323  YC-RMRAS      4521    1      YALE COLLEGE ROOM BASE    Y GROWN BY 30*
324  YC-BDRAS      5370   .01     YALE COLLEGE BOARD BASE   Y GROWN BY 3648
325  YC-TUIT       0.05    1       YALE COLL. TUIT. RATE   # GROWN BY 327
326  YC-FTE        5500.0          YALE COLLEGE FTE        Y
327  EYC-TUIT       .02            GROWTH-YALE COLL TUIT   C 325 & 330

328  YB-YCT                       YALE COLLEGE TUITION      S 325*326
329  G-TUITF       0.050    1       GRAD. FULL TUIT. RATE   # GROWN BY 331
330  G-FTEF        1196            GRADUATE FTE - FULL     Y
331  BG-TUIT        .02            GROWTH-GRAD. TUITION    C 329 333

332  YB-GRAFT                     GRADUATE-FULL TUITION     S 329*330
333  G-TUITH       1.730    1       GRAD.-4TH YR TUIT RATE# GROWN BY 331
334  G-FTEH         474            GRADUATE FTE - 4TH YR Y
335  YC-RGH         .10            RINCH BG INC-4TH FTE*RC

336  YB-GRAD4                     GRADUATE 4TH YR TUITION S 333*334
337  G-DISS         .100            GRADUATE DISS. FEE    # NOT GROWN
338  G-FTED         274             GRADUATE FTE - DISS.  Y
339  YC-BDH        1.161    1       YALE COLL. BOARD RATE # GROWN BY 364

340  YB-GRADD                     GRAD. DISSERTATION FEE    S 337*338
341  P-TUIT       3.9740    1       PROF. TUITION RATE      # GROWN BY 343
342  P-FTE         1506            PROFESSIONAL SCHLS FTE*
343  EP-TUIT        .02            GROWTH-PROF SCHLS TUITN 341

344  YB-PROF                      TOTAL PROFESSIONAL SCHLS  341*342
345  YC-RMR         .00            RINCH BM INC-4TH FTE*RC
346  YC-BMP        1.080    1       YALE COLLEGE ROOM RATE#GROWN BY 347
347  EYC-RM         .01            GROWTH - YC ROOM RATE   C 346 & 348

348  Y2-YCRM                      YALE COLLEGE ROOM         S 323+303
349  YC-DIF                         # OF INCREMENTAL FTE'S S 358 - 326
350  YB-YMED       -003    1     TRANSFER TO MEDICINE      Y GROWN BY 327
352  YB-GTOT                     TOTAL GRADUATE SCHOOL     S 332+336+350
353  YB-OTHRM      1095    1     OTHER ROOM                Y GROWN BY 354
354  EYB-ORM        .01            GROWTH-OTHER ROOM       C 353
355  YB-OTHBD       663    1     OTHER BOARD               Y GROWN BY 356
356  EYB-OBD        .01            GROWTH-OTHER BOARD      C 355
357  YB-TOTAL                    TERM BILL INCOME          S 359+352+304+353+355
358  YB-BASE                     YALE COLLEGE-BASE FTE     I 326
359  YB-YCTOT                    TOTAL YALE COLLEGE        S 328+365+368
360  YB-BD1                 1    TERM BILL INCOME          S

361  YB-BD2                 1    ASSUMPTIONS-AID & T-BILLS
362  YC-IRCB                     INCREMENTAL BOARD INCOMES 309*335*339
363  YC-IRCRB                    INCREMENTAL ROOM INCOME S 340*345*346
363  YB-CALC                     CALC. GROWTH OF YB TOTAL S 357/363
```

```
164  ETC-BD          .01            GROWTH - TC BOARD RATES 139 & 145

165  TB-TCBD                        TALE COLLEGE BOARD      $ 324+162
166  SA-GD6          .76925           $ OF GRAD FTE-AID PERC
167  SA-GD&S         .83646           $ OF FULL GRAD TUIT    C
168  SA-PS           .60000           $ OF PROF FTE-AID PERC
169  SA-P&S          .52370           $ OF PROF TUITION      C
170  SA-TCS          .39135           $ OF TC FTE ON AID     C

171  SA-FC          2.8510    1       AVG. FAMILY CONTRIB.   # GROWN BY 175
172  SA-SELFH       2.120     1       MAXIMUM SELF HELP      # GROWN BY 176
173  SA-JUNK        1.000     1       MISC. STUDENT BUDGET   # GROWN BY 177
174  SA-OUT          1604     1       OUTSIDE SCHOLARSHIP    T GROWN BY 178
175  ESA-FC           .02             GROWTH-FAMILY CONTRIB.G 171
176  ESA-HELP         .02             GROWTH-SELF HELP LEVELG 172
177  ESA-JUNK         .01             GROWTH-MISC. BUDGET    G 173
178  ESA-OS          -.01             GROWTH-OUTSIDE SCHOL   G 174

179  SA-AIDTC                       TALE COLLEGE AID        $ SEE NOTE SA-A
180  SA-AIDG                        GRADUATE SCHOOL AID     $ 166*167*329*162
181  SA-AIDP                        PROFESSIONAL SCHOOL AID $ 168*169*181*162
182  SA-TOTAL                       STUDENT SCHOLARSHIP AID $ 179+180+181+186
184  SA-GWTH                        CALC. GROWTH OF STUD AIDS 182/183
185  SA-GFTE                          TOTAL GRAD FTE        $ 9+(330*333/329)

186  SA-HLTH         185    1       HEALTH CENTER AND OTHER I GROWN BY 187
187  ESA-HLTH        .01               GROWTH OF OTHER AID   G 186
188  SA-SD1                   1     STUDENT SCHOLARSHIP AID R
189  SA-SD2                   1      ASSUMPTIONS-STUDENT AID R NOT USED
190  SA-TBT                           TOTAL TC TERM BILL     $ 325+339+346

670  TB-INCOS        .90              GEN FTE-$ OF AVG. AID C
671  TB-AIDB                        AVERAGE TALE COLL. GIFT $ 179/326
672  TB-PCO                         AID AS $ OF TB INCOME   $ 182/357
```

T = physical quantity (volume)
@ = unit rate or cost
T = total dollar amount
G = growth rate
I = initialized
S = calculated (e.g., subtotal)
C = coefficient

File 2: Budget Functions (selected)

```
320 * 325 326                                  TERM BILL INCOME ****
332 * 329 330                                    INCOME = TUITION & FEE STUDENTS
336 * 333 334
340 * 337 338
344 * 341 342

350 I 325                                      OUT BASE 5017 COLLEGE FEE STUDENTS
349 - 326 350                                  FIND CURRENT WORDS BASE FTE.
352 * 349 335 339                              ) INCREMENTAL ROOM & BOARD.
383 * 348 345 346                              )
385 + 329 362

348 + 323 383
350 + 328 365 368
362 + 332 336 360 350
357 + 352 364 353 355 359
363 I 452                                      ) THIS SECTION COMPUTES YEAR TO

363 / 357 353                                  ) YEAR GROWTH OF TOTAL TERM BILL
363 - 363 450                                  ) INCOME. (YEAR 357)
363 * 363 451                                  )
363 L 363                                      )
390 + 325 339 346                               INCREASE/DECREASE AID ****

385 * 334 333                                   ) COMPUTE TOTAL GRADUATE FEE
385 / 385 329                                   ) INCREASE HALF AND FULL
385 + 330 385                                   ) TUITION FEES.
380 * 366 367 329 385                          GRADUATE AID.
381 * 368 369 341 342                          PROFESSIONAL SCHOOLS AID.

379 + 373 390                                   ) TALK COLLEGE AID. 8PS BUDGET...
379 - 379 371 372                               ) LESS FAMILY CONTRIB'N & SELF HELP.
379 * 379 370 350                               ) FINDS FTE AND $ ON AID.
379 - 379 374                                   ) LESS DECISION DIFF.
681 * 350 ,70                                    ) NUMBER OF BASE FTE ON AID.

680 / 379 681                                   ) AVERAGE BASE AID.
680 * 680 670 369 370                           ) AID FOR INCREMENTALS FTE'S.
379 + 379 680                                   ) NEW AID TOTAL.
681 * 326 370                                   ) NUMBER ON AID.
671 / 379 681                                   ) NEW AVERAGE AID.

382 + 380 381 379 386                          AND OF TOTAL AID.
672 / 382 357                                  FIND AID AS FRACTION OF INCOME.
384 I 452                                       ) THIS SECTION COMPUTES YEAR
384 / 382 384                                   ) TO YEAR GROWTH OF AID TOTAL
384 - 384 450                                   ) (VARIABLE 382). USE 450 IS

384 * 384 451                                   ) CONSTANT '000000'. USE IS 1.0.
384 L 384                                       ) 451 IS 100.
```

File 2: Related Functions by name (alphabetical)

TB-CCC	0	TC-CCCC	TC-FTE			
TB-GRAPH	0	G-TCCTP	G-FTCP			
TB-GRAPH	0	G-TCCTE	G-FTCE			
TB-GRAPH	0	G-CCCC	G-FTCC			
TB-FROM	0	F-TCCT	F-FTE			
TB-BASE	I	TC-FTE				
TC-DIF	-	TC-FTE	TB-BASE			
TC-INCR	0	TC-DIF	CC-ONE	TC-ONE		
TC-INCRE	0	TC-DIF	TC-ONE	TC-ONE		
TB-CCC	+	TC-CCCCC	TC-INCR			
TB-CCC+	+	TC-CCCC	TC-INCRE			
TB-CCCCC	+	TB-CCC	TB-CCC	TB-CCC		
TB-CCCC	+	TB-CCCCC	TB-CCCCC	TB-CCCC	TB-TWO	
TB-TOTAL	+	TB-CCCC	TB-FCCC	TB-CCCCC	TB-CCCC	TB-CCCC
TB-CALC	I	CCC1				
TB-CALC	/	TB-TOTAL	TB-CALC			
TB-CALC	-	TB-CALC	CCC1			
TB-CALC	0	TB-CALC	CCC0			
TB-CALC	L	TB-CALC				
SA-TOT	+	TC-TCCT	TC-ONE	TC-ONE		
SA-GPTE	0	G-FTCC	G-TCCTP			
SA-GPTE	/	SA-GPTE	G-TCCTP			
SA-GPTE	+	G-FTCP	SA-GPTE			
SA-ECC	0	SA-CCC	SA-CCCC	G-TCCTP	SA-GPTE	
SA-ECC	0	SA-FC	SA-FCC	F-TCCT	F-FTE	
SA-ECCC	+	SA-JCCC	SA-TCT			
SA-ECCC	-	SA-ECCC	SA-FC	SA-DELTA		
SA-ECCC	0	SA-ECCC	SA-TCE	TB-BASE		
SA-ECCC	:	SA-ECCC	SA-CCT			
SCRATCH1	0	TB-BASE	SA-TCE			
SCRATCH2	/	SA-ECCC	SCRATCH1			
SCRATCH2	0	SCRATCH2	TB-INCRE	TC-DIF		
SA-ECCC	+	SA-ECCC	SCRATCH2			
SCRATCH1	0	TC-FTE	SA-TCE			
TB-ECCE	/	SA-ECCC	SCRATCH1			
SA-TOTAL	+	SA-ECC	SA-ECCF	SA-ECCC	SA-DLTE	
TB-FRE	/	SA-TOTAL	TB-TOTAL			
SA-GPTE	I	CCC1				
SA-GPTE	/	SA-TOTAL	SA-GPTE			
SA-GPTE	-	SA-GPTE	CCC1			
SA-GPTE	0	SA-GPTE	CCCC			
SA-GPTE	L	SA-GPTE				

File 1: Growth Functions (selected)

```
505 0 507                          TERM BILL INCOME
563 + 317                       PASS TOTAL TO CALC. INTR.
559 0 331                       ) GROW GRAD TUITION RATES.
333 0 371                       )

529 0 559                       ) GROW UC BOARD.
330 0 364                       )
351 0 353                       GROW PROPOSD. GRD. TUITION.
365 0 367                       ) GROW SALE COLLEGE WORK.
323 0 347                       )

350 0 307
353 0 350
355 0 356
371 0 375                        SCHOLARSHIP AID
384 + 38\                       PASS TOTAL TO CALC. GROWTH.

372 0 376                       GROW SELF HELP.
373 0 377                       GROW PERSONAL EXPENSES.
375 0 378                       GROW TOTAL OUTSIDE GIFT.
386 0 387                       GROW TOTAL OTHER AID.
202 0 231                       GENERAL EXPENSES
```

File 1: Growth Functions in Rows (selected)

```
TC-TUIT    0  TTC-TUIT
TB-CALC    +  TB-TOTAL
G-TUITF    0  BG-TUIT
G-TUITG    0  BG-TUIT

TC-BOARD   0  TTC-BO
TC-ROM     0  TTC-BO
P-TUIT     0  BP-TUIT
TC-RMB     0  TTC-BR
TC-MEAL    0  TTC-MP

TB-THRD    0  TTC-TUIT
TB-OTHR    0  TTB-CON
TB-OTHRO   0  TTB-CHO
TA-FC      0  TTA-FC
RS-CNTR    +  TA-TOTAL

TA-SELFG   0  TTA-SELF
TA-JOBS    0  TTA-JOBS
TA-OUT     0  TTA-GS
TA-PLTG    0  TTA-PLTG
```

Appendix D